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THE ELECTRIC LIGHTING ACT.

SCARCELY a discordant note was sounded in the House of Lords on Tuesday night when Lord Thurlow sought permission to read his Bill for the amendment of the Electric Lighting Act (1882) a second time. Lord Lingen, it is true, suggested that local authorities are entitled to more consideration than the framers of the Bill seemed disposed to give them; but his protest was of the mildest form, and was drowned amidst the chorus of approval which came from both sides of the House. Lord Houghton was favourable to the second reading, and suggested that in committee an addition should be made, with the character of which no one interested in electric lighting will be inclined to cavil; the Earl of Crawford and Balcarres signified his hearty approval of the principle of payment for goodwill on the compulsory purchase of a successful undertaking; Lord Bramwell, a power in himself, laid it down as an indisputable proposition that legislation of a remedial nature is absolutely necessary; and, lastly, no less a personage than the Prime Minister supported the second reading, in terms which left no room for doubt as to the direction of his sympathies. What strikes us as being rather an extraordinary statement, however, calls for remark. Lord Houghton is reported to have said that Lord Thurlow's Bill provides that local authorities shall have nothing less than a veto upon any undertaking in their district. We must confess our inability to find in the Bill any clause which suggests, to our minds, at least, such a conclusion. If there be anything admitting of such a construction, no doubt it will be excised in committee, and Lord Houghton's recommendation, that provision should be made for reference to the Board of Trade in the event of the local authority objecting to a lighting scheme, adopted.

Lord Thurlow's temperate, yet forcible, statement of the case for reform will meet with the commendation of all who have the cause at heart. The language of the Prime Minister will afford still further matter for congratulation: he playfully satirised the "intelligent horror" of the Board of Trade at the position in which it found itself with regard to the gas and water companies, and pointed out how that horror led to its undue severity towards the electric light, which it absolutely stifled, so that while other countries can boast of its extensive public utilisation, in this country it cannot be used except by those institutions or persons who are in a position to produce the current on their own premises and by means of their own machinery. No intelligent member of the community, who is at the same time disinterested, can imagine, any more than Lord Salisbury, why Parliament has so long permitted such a state of things. In the first excited moments of high pretension and rash speculation no doubt the repressive action of the Act would have been extremely beneficial: but the "bubble" soon burst, and the policy of maintaining repressive legislation for such a lengthened period resembles too much the action of the man who locks and bars his stable doors after his horses have fled. The Act, we are willing to concede, has actually effected a good purpose in preventing hasty enterprise and in stopping the rush of capital into ill-considered schemes; but a considerable period has elapsed since any such influence was required, and to-day, as for at least two years past, it acts and has acted as a check to the development of a useful and highly valuable industry.

With the Act of 1882 before them it is not remarkable that local authorities have refrained from taking advantage of the power granted them to themselves undertake electric lighting. They were quite prepared, if after the lapse of years some other body succeeded in creating a paying business, to appropriate that business, seeing that they were not called upon to pay more for the privilege than they might easily realise the next day by the re-sale of the plant and material. But as to initiating an undertaking, that was quite another matter, and they possessed neither the gift of foresight nor the spirit of enterprise to lead them into such a course. We do not believe for a moment that they have willingly occupied the position of dogs in the manger which Lord Salisbury ascribes to them, for few town corporations or local boards object to the beautifying of their streets, provided they have not themselves to pay heavily for it. Two or three town authorities certainly did petition Parliament last year against any change in the legislation affecting electric lighting; but we imagine that there were other causes at work than disinterested concern for the condition and welfare of the town and its inhabitants, and it is our belief that the majority of local authorities in this country will be contented with the powers which the Act as amended by Lord Thurlow's Bill would vest in them.

LONG DISTANCE TELEPHONY.

THE recent meetings of the Society of Telegraph-Engineers and Electricians were much enlivened by the animated discussion which took place on Professor Silvanus Thompson's paper on "Telephonic Investigations;" and an interesting phase was reached when Prof. Thompson proceeded to give his reply to the numerous criticisms which his paper had evoked, more especially when the remarks which had been made by Mr. Preece were criticised. In the latter case, the general impression seems to be that the Professor in his reply completely routed his opponent; but an unbiassed examination of the statements will, we think, rather lead to the conclusion that, apart from the more personal portion of the attack and defence, the scientific questions at issue were by no means wholly disposed of. To a considerable extent Prof. Thompson and Mr. Preece

appear to have been at cross purposes. The causes which render long distance telephony difficult are two-fold; there is first the cause which renders the possibility of getting speech through at all a difficulty, and to avoid this cause is, we agree with Mr. Preece, a question of the line wire pure and simple. With an iron wire, any kind of decent speaking through a longer distance than about 150 miles is practically impossible, owing to magnetic inertia; with a copper wire good speech through 1,000 miles of line is quite practicable. Next comes the point upon which we agree with Prof. Thompson, and that is that in cases where speaking is impossible in consequence of external disturbances, then the matter is one of the kind of instruments used. Professor Thompson took exception to Mr. Preece's contention that nothing could be gained by using more powerful transmitters, if the object aimed at was the overcoming of magnetic inertia (*not* external disturbances). He based his argument on the fact that Sir William Thomson in his attempts to increase the speed of working on submarine cables attacked the problem from the instrument and not the line side; this is perfectly true, but Sir William Thomson did not attempt to get increased speed by using transmitters of greater power, as he knew, indeed pointed out (as Mr. Preece stated), that the problem could not be solved in this way. Prof. Thompson, however, apparently has made no attempt to obtain long distance speaking by any other means than increasing the power of the transmitter. His contention that a powerful transmitter may enable speech which is otherwise inaudible to be heard is quite beside the point; it is well known (though not to Prof. Thompson it appears) that failure of speech on long iron wire lines is not due to feebleness of utterance but to indistinctness due to *muffling*, and no increase in the power of muffled sounds will render them more articulate.

UNDERGROUND versus AERIAL TELEGRAPH LINES.

(*Continued from page* 146.)

IN the last article it was pointed out that if we consider two conductors of equal gauge, the one being erected as an aerial line, the other placed underground, that it seems improbable that the underground wire can be made to have a less static capacity than about 10 times that of the overhead wire, and consequently that the utmost working speed in one case would be 10 times less what it would be in the other. Our correspondent, Mr. T. O. Callender, in our last issue says:—"It must be borne in mind that the figure ·0135 microfarads per mile for an overhead line, is of one of the most favourable conditions, and is far from permanent in this unsettled climate of ours." Mr. Callender in making this statement has made a not uncommon error: as a matter of fact, the electro-static capacity of a line is quite independent of weather, *i.e.*, of the insulation of the wire, just as a gallon measure has a capacity of a gallon whether it is leaky or not. It is true that it is impossible to obtain the full discharge from an aerial wire when the insulation is low, because a considerable portion leaks out through the insulators, *i.e.*, the capacity *appears* to be less in wet than in dry weather, that is to say, the working speed would be *greater*. The value ·0135 which we gave is the actual capacity obtained from a line when the insulation per mile of the wire was 70 megohms, and when the experiment showed that the whole discharge was received through the measuring instrument; had the insulation of the line been low the apparent capacity would have come out much *lower*, not higher as our correspondent thinks. It should also be explained that the resistance per mile of the wire which gave the capacity in question was under 6 ohms, the wire being of *copper* of 150 lbs. weight per mile. As a matter of fact, No. 11 *iron* wire of 28 ohms per mile (the gauge and resistance mentioned by Mr. Callender) is never used except for short local circuits, the actual gauge and resistance of the main wires where iron is used being No. 7½ of 12 ohms, the wires being of best galvanised iron; the extreme capacity of these wires averages about ·017 microfarads. The working power in the case of the copper wire (a description of wire coming into extensive use) would be expressed by

$$\cdot0135 \times 6 = \cdot0810$$

and not by

$$\cdot0135 \times 28 = \cdot38$$

as given in our correspondent's letter.

In the case of an iron wire of No. 7½ gauge we get

$$\cdot017 \times 12 = \cdot204.$$

As our correspondent points out, static capacity is only one of two factors in the question of working speed, the other factor being resistance, and the question therefore arises, is it possible to obtain increased speed capacity by enlarging the conductor? Now, the speed capacity of an underground wire is expressed by the formula

$$S = \kappa d^2 \log. \frac{D}{d}$$

where D is the diameter of the dielectric, and d the diameter of the conductor. The value of S is a maximum when

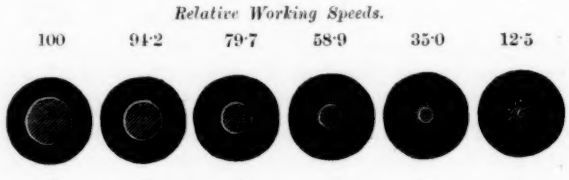
$$d = \frac{D}{\sqrt{\epsilon}}$$

or

$$\frac{d}{D} = \cdot6 \text{ approximately.}$$

It is interesting to observe the diminution in the value of S which takes place as the value of d is diminished.

The fig. shows the sections of six insulated wires, the diameters of the insulating coverings in all of which are the same, but whose conductors vary in size.



Relative Working Speeds.					
100	94·2	79·7	58·9	35·0	12·5
·6	·5	·4	·3	·2	·1
Ratio of Diameters.					
2·78	4·5	6·25	11·1	25·0	100
Ratio of Resistances.					

From the values given in the fig. it will be seen that the speed does not increase directly as the diameter of the conductor increases, for the obvious reason that the increase in the diameter of the wire means a corresponding increase in the capacity. Thus we see that by increasing the diameter of the wire from 1 to 2, that is, by diminishing the resistance from 100 to 25, or by reducing it to one-fourth, we increase the working speed from 12·5 to 35·0, or increase it about three times and not four times. In this case we have assumed the diameter of the conductor in the first place to be very small compared with the insulating covering; if, however, the diameter had been such as to give a speed of 58·9, then an increase in diameter sufficient to reduce the

resistance from 11·11 to 2·78, that is, to reduce it to one-fourth, would only increase the speed to 100, or less than double.

Assuming that the relative diameters of the conductors and insulating coverings are such as to give the maximum speed, it is interesting to know what size of conductor would be required to give a speed equal to that attainable on the land line to which we referred, viz.. that having a capacity of ·0135 and a resistance of 6 ohms; we have, in fact, to determine what diameter the wire should have in order to obtain the value ·0135 × 6, or ·0810. Now a copper wire (No. 18) having a resistance of 23 ohms per mile and covered with gutta percha to a thickness of No. 7½, has a capacity at its best of about ·230 microfarads per mile. Taking the diameter of the dielectric at 172 mils., then the diameter which the conductor would have, supposing the relative diameters of conductor and insulator were those for maximum working speed is,

$$172 \times \cdot 6 = 103 \cdot 2 \text{ mils.}$$

Now the diameter of a No. 18 wire is 49 mils., and this with a dielectric of 172 mils. gives, as stated, a capacity of ·230 microfarads, consequently if the conductor were 103·2 mils. instead of 49, the inductive capacity, F, would be given by the proportion

$$F : \cdot 230 :: \log. \frac{172}{49} : \log. \frac{172}{103 \cdot 2}$$

or

$$F = \cdot 230 \frac{\log. \frac{172}{49}}{\log. \frac{172}{103 \cdot 2}} = \cdot 565 ;$$

and the resistance of the wire would be

$$23 \times \left(\frac{49}{103 \cdot 2} \right)^2 = 5 \cdot 19,$$

consequently the coefficient of working speed would be

$$5 \cdot 19 \times \cdot 565 = 2 \cdot 93$$

Now if we preserve the relative diameters of the conductor and dielectric constant, then the working speed in insulated wires of different sizes will vary as the square of the diameters of the conductors, consequently the diameter of a conductor (which is so proportioned to the diameter of the dielectric as to give a maximum working speed) necessary to give a working coefficient of ·081 (the coefficient for the overhead wire) must be

$$D = 103 \cdot 2 \sqrt{\frac{2 \cdot 93}{\cdot 081}} = 621 \text{ mils.}$$

or more than *half an inch!* If the material with which the wire is insulated has a greater specific inductive capacity than that of gutta percha then, of course, the conductor would have to be still larger.

The weight of a copper wire 621 mils. in diameter and one mile long would be 6,163 lbs., or about 3 tons.

Supposing that the price of gutta percha and copper were *bulk for bulk* identical, then the proportion of gutta percha and copper for obtaining maximum speed would also be the cheapest proportion, but if this is not the case, then it may be more economical, say, to reduce the size of the conductor and to make up for the increased resistance that this would cause, by adding to the thickness of the insulator and thus reducing the capacity. This arrangement would, however, only be economical if the value of the added quantity of gutta percha were less than the value of the amount of copper by which the conductor had been reduced.

(*To be continued.*)

Telephonic Investigations.—Prof. S. P. Thompson, in reply to Mr. Preece's criticism on his paper at the Society of Telegraph Engineers, expressed his inability to decide whether Mr. Preece meant to "damn him with faint praise" or praise him with faint damns. We presume Mr. Preece will have no such difficulty in interpreting the reply of the Professor.

THE LIGHTING OF TRAINS.*

By HAROLD CORDEROY, Student of K.C.L.

MR. PRESIDENT AND GENTLEMEN,—The lighting of railway carriages is a very important factor in relation to the comfort of the travelling public, and one which has always been, more or less, prominently to the fore. Although within the last two or three years much has been done towards improving the illumination, there still remains a good deal to do in this direction, notably on some lines, which ought, and I hope will, soon be attended to.

There are three different modes of lighting, which will consider in the order of their date of application.

1. *By Oil.* 2. *By Gas.* 3. *By Electricity.*

We will first refer to oil lamps.

On all the lines such as the London and North Western, the Great Western and Midland, &c., the companies manufacture lamps of their own, which are simple in construction and do not differ materially from one another. Until lately all trains were lit by these lamps, and the majority still continue to be so, for although many different and some good patents have of late years been brought forward, the initial expense of changing the system is so great that the old lamps continue to be used. The lamps ordinarily manufactured by the companies consist of a metal case containing an annular reservoir for the oil. The supply pipe communicates with this reservoir projecting vertically downwards, and generally contains a small loosely fitting rod, which allows (or rather is supposed to allow) the oil to percolate through drop by drop.

To this supply pipe is attached the wick holder. A series of holes are pierced in the sides of the lamp protected by wind guards, and through these holes the air enters. The products of combustion ascend a metal chimney, which reaches into the roof of the lamp, and thence they pass into the outer air.

The body of the lamp, consisting of the reservoir, burner and chimney, is movable, and the parts are easily detachable and cleaned. To the under side of the reservoir a polished reflector is attached, which throws the light down into the carriage. The oil used is ordinary colza or rape.

These lamps, if properly cleaned and well trimmed will, with a good wick and good oil, give an excellent light; but these requirements are difficult to comply with, and as a natural consequence the light is generally very inferior.

There are several points which should be noticed here as to the disadvantages of these lamps; for instance, the oil reservoir is above the burner, but filled from beneath in the better constructed lamps, requiring that the cover should be air-tight.

After the lamp has been burning for some time and the oil descends to a lower level, a certain amount of air naturally bubbles up (entering through the burner) and remains above the oil. The reservoir, though kept cool when the carriage is in motion, rises slightly in temperature directly it comes to rest, and the air expanding forces the oil out of the burner, so that there is invariably a certain amount of leakage.

The float and valve contrivance for percolation is also peculiarly liable to break, so the leakage is frequently considerable. The only sure remedy for this is to have the oil reservoir *below* the burner, but this would be impracticable, as the candle-power is so low (averaging 2 and at the best 3½), that if the flame were partially hidden the amount of distributed light would be reduced to a minimum.

A further point of inconvenience is the position of the burner in the middle of the lamp, so that the shadow of the wick holder obstructs a good deal of light. The trimming of these lamps is likewise a difficulty, and when so large a number have to be attended to it is not to be wondered at that the wicks

* Read before the King's College Engineering Society, February 22nd, 1887.

are occasionally cut unequally, and therefore produce a smoky flame.

An endeavour was made to obviate this last difficulty by Defries, who constructed a patent wick, cut to the same curvature both ends and made to fit exactly into a tube with a similar curvature at the base, so that, in consequence, no trimming was necessary. This plan was not found to answer, because so much of the wick was left to project, and the flame being very broad, produced such an intense heat as to melt portions of the lamp. It is, nevertheless, a very practical invention, and one which might, I think, be successfully adopted if the wick were manufactured of uniform breadth and did not project too far.

The low candle-power of these lamps is due to the employment of colza oil as the illuminant; for the chemical constituents of the oil are such that there is too much carbon in the flame, and, in consequence, a yellow smoky light is obtained, the carbon not being all consumed. A very good supply of air is necessary in order to obtain at all a good light, but even then it is unequal to that produced by petroleum. The objection, however, to the use of the latter is its low "flashing point," making it very unsafe.

The ingenuity of inventors has overcome this drawback of petroleum by various methods, particularly by placing the oil reservoir above the burner, and keeping the former cooled by a constant current of air, as in the Ridsdale and Silber lamps, which we will now consider.

The *Ridsdale lamp*, which you see here in the form generally adopted on the railways, was patented by Shallis and Thomas, and is manufactured by Messrs. Ridsdale & Co., of the Minories, London.

I am indebted to Messrs. Shallis and Thomas for their kindness in supplying me with two specimens of their lamps, one of which you see here trimmed and alight, whilst the other I have arranged so as to exhibit the internal structure. All overhead carriage lamps are necessarily of somewhat similar construction, and in this lamp there is, as before, an annular reservoir within the metal case; but the burner is situated *above* it, at the *side* of the lamp, and not in the centre.

These are the two main features of difference. The wick projects into the burner in an almost horizontal position, dipping at its other end into the oil, which rises by capillary attraction. The burner is so shaped as to have two curved lips bent in towards the flame, so that they deflect the air against it and render combustion much more complete than in the ordinary oil lamp.

The supply of air is plentiful, part of it serving to keep the oil cool, while another current circulating down the lamp reaches the burner in a heated condition. The combustion chamber is lined with white enamel, which constitutes an excellent reflector, and throws the light down into the carriage. The products of combustion pass up a metal chimney into the outer casing, from which they escape into the surrounding atmosphere.

An important feature in this lamp is the absence of a globe, which, of course, reduces the expense considerably, besides having other advantages. One of these is, that any glass must of necessity absorb a certain amount of light, and if it be shaped in the form of a lens (as you see here, where there is one of conical shape), the central portion being made thicker than the edges, is liable to fracture from unequal expansion and contraction. The lamp glass is not entirely dispensed with, as this would be impracticable, but is made to project straight across the base of the lamp. The form with a lens is only made by the patentee at the expressed desire of the railway companies, for it is really less efficient than the other.

The oil used is what is known as "patent heavy mineral oil," though it is possible to use vegetable oils. if circumstances render it advisable.

These lamps can be observed in operation on the Great Western, Great Northern and Midland railways.

The candle-power of the Ridsdale lamp is 12, and its cost as compared with that of the ordinary oil lamp is well shown by the following statistics. These are the particulars of an actual test, conducted, I think, by the Great Eastern railway, in 1884. They show the cost of 30 roof lamps, Shallis and Thomas's patent, as compared with the cost of 30 roof lamps, burning vegetable oil.

The test lasted one month, and the cost includes material used, time for trimming, breakages and repairs.

Week ending.	Cost per gall. mineral oil.	Shallis and Thomas's lamp.	Cost per gall. Vegetable oil.	Vegetable oil lamp.
1884.	s. d.	£ s. d.	s. d.	£ s. d.
July 12	1 0	0 11 1	2 0	1 3 4
„ 19	0 9	0 9 1	2 0	1 17 10
„ 26	1 0	0 11 1	2 0	1 12 4
August 2	1 0	0 11 7	2 0	1 2 10
		2 2 10		5 6 4

Showing a saving of 60 per cent. if the Ridsdale lamp be used.

We will now turn to the "Silber" lamp, manufactured by Messrs. Silber and Fleming, of Wood Street, Cheapside, to whom I must here express my obligations for having furnished me with, first, a railway carriage roof lamp, and, secondly, a head lamp, both of which you see before you.

More than 800 of the roof lamps have already been supplied to the Great Northern railway, while many are also in use on the Great Eastern, the Great Western, Midland, and other railways.

The oil reservoir, as usual, is annular, but here also, situated *below* the burner, thus fulfilling one of the chief requirements—previously referred to—of a successful lamp, as in this manner there can be no leakage.

The wick dips into the oil and enters the burner horizontally, the customary provision being made for raising or lowering. The burner is cylindrical in shape and projects slightly into the combustion chamber, which, being lined with white enamel, reflects the light below into the globe, the lower portion of which is so shaped that it acts as a diverging lens, distributing the rays evenly throughout the carriage. The upper portion of the carriage more especially is illuminated by this lens, which is a greater advantage than it may appear at first sight, as the minutest details of carriage construction are now scientifically considered, and light-reflecting paints and papers are carefully selected for the purposes of internal carriage decoration.

The proper distribution of the air throughout the lamp has been very carefully considered by the patentee. It enters just above the level of the lamp roof and circulates slowly round the combustion chamber, becoming heated in its passage; it then passes through a series of holes in the upper portion of the lamp and flows downwards to the burner.

The oil reservoir is cooled by a supply of air from the carriage, which enters just above the globe and flows in a constant stream round the tank. To light the lamp you lift, as you perceive, a small door and a taper filled with methylated spirits is applied for the purpose of ignition. The lamp gives a light of 12 candle-power.

The oil used is, as before, heavy mineral oil, which although far cheaper than colza gives an infinitely better light. The cost of colza is 1s. 9d. per gallon, whilst the cheapest mineral oil costs only 10½d. or less than half the price, and moreover produces a light of 12 candle-power as compared with one of 3½. About a pint of oil is required to fill a lamp, which then burns for 19 hours.

To steady the lamp body several rods attached to springs are fixed in the roof, and when the latter is shut down, these rods coming into contact with the body, are pushed home against the action of the springs thus nullifying vibration.

The patentee claims that the wick is cut mechanically (as it is called) by a pair of scissors of special design

so arranged as to ensure the projection of the requisite length of wick into the burner. The lamps, it is said, can thus be trimmed very accurately and rapidly, much more so in fact than by the ordinary method.

Another feature of this lamp, as also of the Ridsdale, is that the wick can be regulated from the inside of the carriage by a small key, which, acting like a spanner, turns a rod to which is attached a bevelled wheel.

From the description previously given of these two lamps, namely, the Ridsdale and Silber, it will be seen that the difficulties of the use of mineral oil in lamps have been successfully overcome. In both the reservoir is placed *below* and not *above* the burner (as in the familiar type of the ordinary railway lamp) and the danger from leakage thereby avoided. The arrangements for the supply of air to the burner and its circulation round the chamber are in both cases well effected. The supply for the burner is heated in its passage, whilst that for the circulation round the oil chamber is derived from a different and distinct source and therefore kept cool.

Objection has been taken to the enamel reflectors on the score that the surface cracks under the influence of the heat, and gets begrimed from the deposit of carbon. This can only happen to any considerable extent when the lamp is kept burning a long time in a train "at rest." By far the greater portion of the time, however, the lamp is burning in a train in motion, under which conditions a strong current of air is set up rendering combustion sufficiently complete to prevent this occurring.

In a short stoppage of, say 5 minutes, the current does not diminish to an appreciable extent, and therefore the combustion is practically unaffected. In actual working damage from this cause has not accrued largely; in fact, the makers say that *no* lamp has been returned on this account. It is impossible, however, to conceive a lamp ideally perfect under all the varying atmospheric conditions to which it is necessarily subjected, unless indeed it be electrical.

When comparing these lamps with the ordinary oil lamp at first described, and in common use, it will be seen that great strides have been made in the direction of a pure white well-distributed light of considerable illuminating power.

I have chosen these two lamps as typical, and in my opinion the best examples of recent invention, as they are certainly the most used. Indeed, I personally am not aware that any others are in use at all.

We will now proceed to consider the second mode of illumination, viz., that of *gas*.

Railway carriages have been for some time illuminated by this method, but until about six or seven years ago the ordinary coal gas was employed. Since 1881, however, two new systems of lighting have been largely adopted—Pope's and Pintsch's—in both of which the gas is manufactured from oil and is afterwards introduced in a state of compression to the cylinders. *Pope's compressed oil gas* is manufactured in the following manner:—There are several retorts, generally arranged vertically, and communicating with each other. In the first are two pipes, one inside the other, which descend nearly to the bottom of the retorts. Some liquid hydro-carbon enters through the larger pipe, whilst a small quantity of water flows down the central pipe, and serves to prevent the deposition of solid carbon in the form of lampblack from the heated gas. The oil and water fall into a small crucible placed beneath the pipes. The retorts being heated, the oil which is introduced in the first is vaporised and rises to the top, passing through a valve and pipe into the second. Here the oil vapour descends along the heated sides, and ascending through a central pipe emerges in the form of gas.

Shale oil or paraffin is employed, costing 6d. per gallon, and from each gallon 80 cubic feet of gas are produced; besides which there is a deposit of oily tar in the retorts, for which at present no use has been found, but the chemists are now at work on it, and hopes are entertained that it may yet prove of commercial value.

With two pairs of retorts 400 feet of gas are made per hour, the cost averaging 8s. 3d. per unit of 1,000 feet. If a larger supply of gas is wanted and four pairs of retorts are in use, no further wage expense is incurred, and therefore the cost would be somewhat reduced, probably to 7s. 6d. per 1,000 feet. The cost of fuel is said to be 5d. or 6d. per 1,000 feet, and wages are reckoned as being (with two pairs of retorts) 1s. 6d. to 1s. 8d. per 1,000 feet. After leaving the retorts, the gas is stored in gasometers in the usual way. It is then pumped into storeholders and conveyed to the stations, the cylinders being filled from them by a hose having patent couplings and taps. This is very advantageous as it obviates the necessity of filling the cylinders at a certain place, and also the expense of erecting pumps at the several stations. The gas is stored in these cylinders at a pressure of seven atmospheres.

When coal gas was used this compression was found to diminish the illuminating power 75 per cent., but with Pope's oil gas the decrease is, I am told, only 25 per cent., making the latter, if these figures are correct, three times as efficient as coal gas.

Comparing the systems then, the actual cost of production of Pope's oil gas is two and a half times as much as that of coal gas, but the illuminating power is three times as great, so that finally a saving is effected.

The capacity of the cylinders is 24 cubic feet, and they take three minutes to fill, the supply of gas lasting over 20 hours.

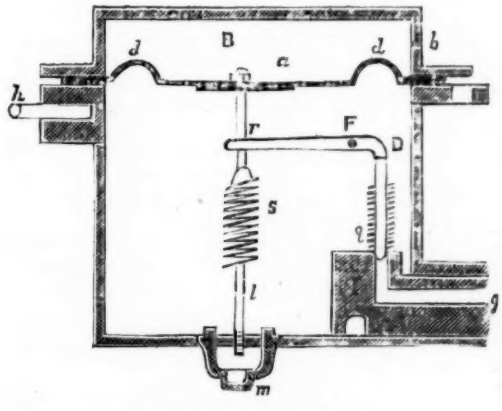
The cost of a complete set of one pair of retorts, engines and gasometers is £600. An additional pair of retorts costs £5 10s.

The lamp used is of special construction, there being a single burner giving a 16 candle-power light. The cost of the lamp is 15s., and it burns half a foot of gas per hour.

An enamelled reflector is placed horizontally above the burner, whilst there is a central aperture up which the products of combustion pass.

The gas requires to be supplied to the burners at a normal pressure, and since it is in a highly compressed condition in the cylinders, a regulator has to be employed.

This is of somewhat complicated construction, consisting of a metal box at the lower end, *g*, of which the



POPE'S REGULATOR.

gas is admitted. The cover fits quite air-tight and holds a diaphragm, *d*, which is made of vegetable parchment treated with glycerine. The diaphragm fits between two iron plates, *a*, clamped together in the centre. The upper is about two-thirds the diameter of the diaphragm, being made so in order to secure a good pressure. In the lid of the box a very minute hole, *b*, is pierced, which allows the entry of air above the diaphragm. A *central* spring, *s*, is attached to the iron plates, having its lower end fixed a rod, *l*, which screws into the bottom of the box. The projecting

portion is protected by a cover, *m*, and this, if removed, allows of the tightening or loosening of the spring with a screwdriver. A lever is attached to the central spring at one end, *r*, whilst the other end, D, being fixed to a conical valve, *q*, opens or closes the latter by its motion. When the pressure of the gas is great the valve is opened and the lever raised, thus tending to depress the central spring and to lower the diaphragm. This is prevented by the pressure of the gas upon it, and the valve is consequently shut again until the pressure is normal.

Pope's gas is employed on the London and North-Western Railway, the Metropolitan, the Midland, the Great Western and others. It is also used for tramway cars, particularly the Birmingham Central Tramways Company, to the courtesy of whose officials I am indebted for the above statistics.

Pintsch's system, though it was only introduced into England in 1880, had been for some time previously in use on the Continent. It is now very generally employed on the railways, as is exemplified on the District Railway, the Midland, the London and South-Western, &c.

The gas is manufactured from any liquid hydrocarbon. There are a pair of retorts 10 inches in diameter, into which the oil enters, and being regulated in its flow by a specially constructed cock, passes through a funnel and thence into an iron tray. Here it remains until it has been vaporised by the heat, upon which it ascends and passes through to the second. The use of the iron tray enables the deposit of carbonaceous matter to be easily removed, also preventing its distribution over the sides of the retort in a solid form.

The gas, after passing through a tar well, is sent through purifiers which contain sawdust and lime spread upon shelves. Over these the gas passes, and the more pernicious impurities being removed, it enters the gasometers. It is transferred to the cylinders at a pressure of 6 atm., though the storeholders contain it at a pressure of 10.

The cylinders are very often old boilers, or, if specially manufactured, are constructed of wrought iron plates about one-sixth inch diameter.

The regulator is a metal box 12 inches in diameter and 6 inches in depth; over the top is stretched a membrane of specially prepared leather, to the centre of which a rod is attached, joined to a lever, which controls the regulator valve. The rod is fixed to a spring the action of which opposes the motion of the diaphragm. This is a very important feature, as the jerky motion of the train has no effect on the valve, and the gas supply therefore remains constant, producing a steady light.

Four hundred feet of gas per hour are manufactured by four retorts, the total cost of the gas being (Mr. Rickman informs me) 6s. to 7s. per 1,000 feet, as against 3s. 6d. for ordinary coal gas.

With coal gas, however, so great was the waste due to compression, that four feet per hour were consumed, whilst with the Pintsch gas the consumption is less than one foot per hour.

The cost of the fittings for one carriage are from £12 to £40, and a complete gas works delivered and erected from £500 to £3,000.

Another method of illuminating trains by gas is the Bower system, but as I am uncertain whether this is still in use, I shall not describe it in any detail. The method adopted is the carburation of coal gas after its manufacture, this carburation being effected in the lamp. An oil reservoir is placed in the latter through which the gas passing absorbs a sufficient quantity to increase the illumination to the required standard. Two gallons of oil per 1,000 cubic feet are necessary for effecting this operation, and as the cost of this is 2s., to which must be added that of the gas which is 3s. 6d., the total cost per 1,000 feet reaches 5s. 6d. However, more gas being burnt per hour on this than on the Pintsch system, the final cost for one lamp is $\frac{1}{10}$d. per hour, being identical with that of the Pintsch.

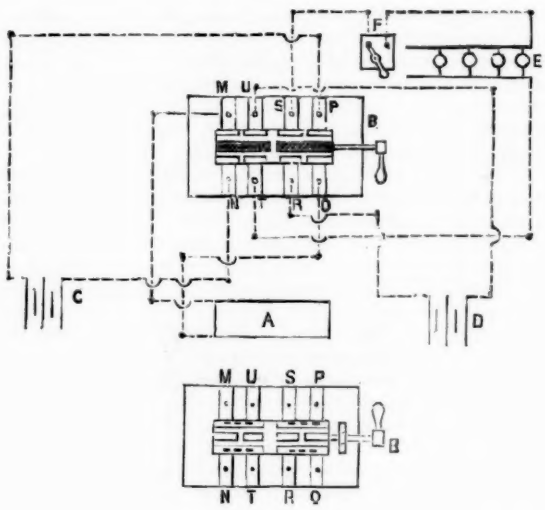
Lastly, we will consider the third mode of illumination, that by *electricity*, which having only lately been adopted opens up a wide field for improvement. If the working cost can be reduced, this system will certainly prove the safest, most convenient, and most simple that can be employed.

At first it appears that electricity might easily be adopted economically in the lighting of trains. The utilisation of the superfluous power to drive a dynamo by employing the waste steam, or the driving of a dynamo simply by the momentum of the train, so that sufficient energy may be stored in the accumulators for the very longest stoppage, are problems much more difficult to deal with than they appear to be.

A very large number of methods have been invented which have proved impracticable in actual working; many of them, for instance, which depend on the constant running of the locomotive are not available, since on the stopping of the latter the train will be left in darkness.

In the method now employed on the London, Brighton and South Coast Railway (which may be considered successful, as it has been in constant use for three or four years) the dynamo is driven from the axle of the brake van, and charges one set of accumulators, whilst another set, previously charged, supply the necessary current to the lamps.

The arrangements of the accumulators, dynamo, and lamp circuit are illustrated in these figures (figs. 1 and 2.)



FIGS. 1 and 2.

A switch is employed, by turning which, the accumulator which is being charged by the machine, can be disconnected and put in connection with the lamp circuit whilst the other battery is shut off from the lamp circuit and connected up with the dynamo.

The direction of the currents are obvious from figure 1. Starting from the $+^{ve}$ pole of the dynamo, A, we reach the point marked, M, on the switch, B, thence crossing to N, through the accumulator, C, and back through P and Q to the $-^{ve}$ pole of the machine, A. Again, for lighting the lamps, the current passes from the battery, D, to the point marked, R, on the switch, across to S, and thence through the lamp circuit, E, and back through T and U to the accumulator, D. On turning the switch the directions of the currents are altered, and flow as illustrated in fig. 2.

The current from the dynamo flows to M, across to U, through the battery, D, and back through R and Q to the machine; whilst the other current, starting from the accumulator, C, flows from P to S through the lamp circuit and back to the battery by T and N. There is a small switch at F, by turning which the

guard can at any moment extinguish the lamps, as, for instance, when the train is travelling in the daylight, and again light them on passing through a tunnel.

A very ingenious piece of mechanism, patented by Messrs. Stroudley and Houghton, is employed for ensuring that the electricity shall be stored independently of the direction in which the dynamo is driven. It also shuts the accumulator out of circuit until the E.M.F. of the dynamo is sufficient to charge it; it automatically excites the field magnets, and, when the E.M.F, has reached the required standard, permits the current from the dynamo to pass to the accumulator. These requirements are effected in the following

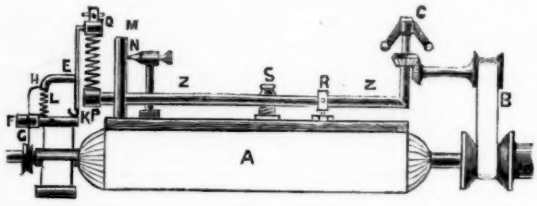


FIG. 3.

manner :—A belt, B, passes round a pulley on the axle of the dynamo, A, and drives another pulley situated vertically above it, and which is attached to a rod working a centrifugal governor, C.

The motion of these governors affects a lever, Z, Z, having a movable fulcrum, R, attached to the frame of the machine. This lever is raised against the action of a spring or weight, S, which therefore regulates the speed at which the axle must be driven in order to effect this action. As the E.M.F. increases with the speed the weight can be adjusted so as to allow the elevation of the lever when the E.M.F. has exceeded a certain limit.

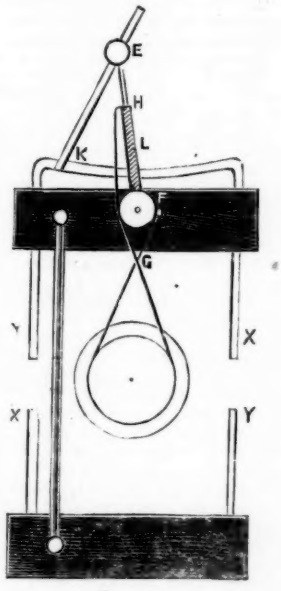


FIG. 4.

The lever has a block, P, affixed to its further end, from which a spring projects vertically upwards and holds another block, Q. When the lever first commences to rise, it lifts the spring and the two blocks, and thereby brings the brushes into contact with the commutator by a method which I shall presently describe. The upper block can only ascend to a certain distance, and then the lever, still acting, compresses the spring and rises until a contact, N, is made which connects the exciting current for the field with the lamp circuit. The E.M.F. still increasing, the lever is further raised until a contact, M, is made, which connects the charging current from the machine to the battery.

Finally, we will consider the mode of automatically making contact between the brushes and the commutator, vide fig. 4.

A pulley is attached to the commutator round which a band of gut, G, passes. One end of this band is fixed to a loose sleeve, F, on the swinging frame of the brushes, whilst the other end is attached to a rod, H, which rises from this sleeve and moves with it. The end of the gut which is fixed to the rod is held tight against the pulley by the action of a spring, L, which constitutes a portion of the before-mentioned rod. When the commutator turns, it slightly turns the gut, and this the sleeve and rod, and the upper end of the latter being cranked and pivoted to another rod, E, having one end at the movable block, Q, previously mentioned in connection with the lever, imparts to this rod a side motion. This latter rod, E, is hooked, at K, to the swinging frame of the brushes and passes from one to the other end of it, according to the direction in which the commutator may be turning.

Having been brought to one end of the frame, the lever raises the upper movable block, Q, and this tilts the swinging frame. The brushes are so attached to this frame that in whichever direction the tilting transpires, a pair of the brushes, X, X or Y, Y, make contact with the commutator.

When the swinging frame is not raised, or, in other words, when the E.M.F. has not reached its assigned limit, no contact is made.

A Brush dynamo is employed in the installation on the London, Brighton and South Coast Railway's trains, and 20 E.P.S. cells are used for each accumulator.

Only two trains are at present lighted by electricity, but, I believe, the company intends to adopt the system on several more.

There is no doubt that electricity possesses a great number of distinct advantages over either oil or gas as an illuminant for railway carriages. The constant trouble and expense of cleaning being entirely saved, and the ease of regulating the whole system by simply turning a switch in the guard's van, constitute by no means the least of these advantages. Again, the small space occupied by the plant (for it is easily contained in a portion of the brake van) is a convenience which can be readily appreciated. It is with a view to these facts that its utilisation must be enforced, for although lamps can be used of a high candle-power, still one of 12, the same as that now reached by both oil and gas lamps, is best suited to the different requirements of production and use.

COMPACT ELECTRIC LIGHTING PLANT.

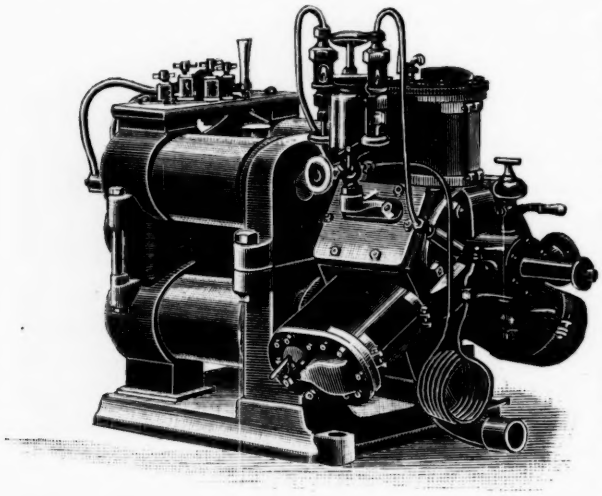
THE very small and neat electric lighting plant shown in our illustration, and to which we briefly alluded last week, was recently shown in operation in combination with a small projector lamp at Mr. Brotherhood's works. It consists of a small 3-cylinder Brotherhood engine, and one of the Brush Corporation's Victoria dynamos, of special construction. The apparatus is intended for use on board ship for the navigation of canals or other narrow waterways. It is, of course, equally applicable for any other purpose where a light and portable apparatus is a desideratum. The dynamo, which is compound-wound, differs from the usual type of Victoria machine in having single-ended magnets, instead of the usual form with two coils on each bar. The pole-pieces are made to encircle the two sides and the periphery as usual, and the general arrangement is adopted mainly to economise space. The speed is 750 revolutions per minute, the E.M.F. being 65 volts, and the current 40 to 60 ampères, according to requirements.

The engine is of the latest Brotherhood type, having 3 inch cylinders and 4 inch stroke, steam pressure, 90 lbs. The following are the overall dimensions of the engine and dynamo :—Length, 2 feet 10 inches ; width, 1 foot 8½ inches ; height, 1 foot 10¼ inches.

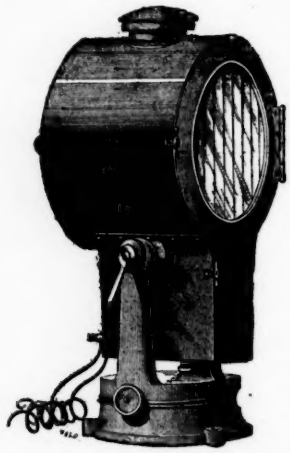
One of the bearings is projected between the magnets of the dynamo, and forms the bearings also of the

dynamo shaft; the two shafts are, in fact, continuous, the armature being overhung, having no outside bearing. The weight of the engine, bed-plate and dynamo is 7 cwts.

The arc lamp which was placed on the wharf was one of the new "Victoria" automatic focussing search-lamps, recently introduced by the Brush Corporation, and was contained in one of their "ahead" lanterns or projectors provided with a "Chance's mirror" (16 inches). The weight of the "ahead" lantern complete is 2 cwts., making the weight of the whole plant 9 cwts.



In place of the usual door or front of plain glass, the lantern has a compound dispersing lens, which converts the parallel beam into a thin wedge of light, practically parallel vertically. This has a great advantage over the usual form of parabolic reflectors, which send out a cone of light, as it flattens the beam and distributes the light in an economical manner over the object or area which it is desired to illuminate. There



is the further advantage that an observer can look directly over or under the beam, instead of having to direct his gaze through an atmosphere where the scattering of light by particles of water is apt to somewhat dim the vision. The "ahead" lantern or projector is capable of vertical and horizontal adjustment.

The "Victoria" automatic search lamp has been brought out by the Brush Corporation to avoid the many drawbacks connected with the working of powerful search lights by hand, as has hitherto been the custom. The fact that the lamp is quite automatic enables the person who is directing the projector to devote the whole of his attention to it. The lamp is exceedingly simple, consisting mainly of a core and solenoid operating the carbons by a cord passing over a suitable pulley.

POST OFFICE TELEGRAPHS.

AN account showing the gross amount received and expended on account of the telegraph service in the year ended 31st March, 1886, and the balance of the expenditure over receipts (pursuant to Act 39, Vict. c. 5, s. 4):—

Gross amount received by the Post Office in respect of telegraphic messages, private wire rentals, special wire rentals, &c., in the year ended 31st March, 1886, as per finance accounts, page 19, £1,974,852 11s. 9d.; less amount paid to submarine telegraph companies, &c. (£226,174 2s. 3d.), and message money refunded, &c. (£3,622 1s. 5½d.), £229,796 3s. 8½d.—£1,745,056 8s. ½d.; amount of extra receipts, as per appropriation account, £13,113 2s. 8¼d.; amount received in respect of telegraph old materials—by the Office of Works, London, £299 0s. 7d., by the Office of Public Works, Dublin, £51 2s. 4d.—£350 2s. 11d.; amount received by the Stationery Office in respect of telegraph waste paper, &c., £1,748; value of telegraph services performed for other public departments without remuneration, £26,997; balance of expenditure over receipts, £45,137 3s. 2½d. Total, £1,832,401 16s. 10¾d.

Amount expended by the Post Office in respect of salaries, rent, maintenance of telegraphs, &c., as per appropriation account, in the year ended 31st March, 1886, £1,733,104 11s. ¾d.; amount expended by Office of Works, London, from the grant for Revenue Department buildings in respect of the telegraph service, as per appropriation account, sub-heads P., Q., R., and S., £61,021 13s.; amount expended by the Stationery Office in respect of the telegraph service (not shown separately in the appropriation account), £31,391; amount expended by the Office of Public Works, Dublin, from the grant for public buildings, Ireland, in respect of the telegraph service (not shown separately in the appropriation account), £3,331 6s. 5d.; amount expended by the Inland Revenue Department in respect of the issue of stamps used on telegrams (not shown separately in the appropriation account), £237; amount expended by the exchequer and audit department in auditing the accounts of the telegraph service, £2,161 1s. 7d.; amount expended by the Treasury for rates and contributions in lieu of rates in respect of the telegraph service, £1,155 4s. 10d. Total, £1,832,401 16s. 10¾d.

Statement additional to the foregoing account, prepared in accordance with the following paragraph of Sect. 4 of 39 Vict. c. 5, viz., "There shall be added to such account a statement of the amount expended during the said year on account of the annual charge for the securities created for the purpose of the Telegraph Acts, 1868 to 1870, and any Acts amending the same, and of the surplus, if any, which, after deducting from the said balance the amount of such anuual charge, remains as a sinking fund for the redemption of the said securities; and a statement of the mode of application of such surplus":—

Capital stock (Consols) created in respect of money raised for the purchases of telegraphs, &c., viz.: Under 32 & 33 Vict. c. 73, £7,588,757; under 34 & 35 Vict. c. 75, £1,079,043; under 36 & 37 Vict. c. 83, £1,347,152 2s. 11d.; under 39 Vict. c. 5, £525,486 0s. 5d.; under 40 & 41 Vict. c. 30, £407,735 2s. 9d.—£10,948,173 6s. 1d. Less—Stock purchased and cancelled on account of surplus balances: Period to 31st December, 1870, £54,771 17s. 8d.; year to 31st December, 1871, £12,830 3s. 3d.—£67,602 0s. 11d. Capital stock, £10,880,571 5s. 2d.; interest for one year to 5th January, 1886, £326,417 2s. 9d. Amount expended on account of the charge for the year ended 31st March, 1886, £326,417 2s. 9d.; excess of expenditure over receipts, as shown by the foregoing account, £45,137 3s. 3d.; deficiency of telegraph revenue to meet expenditure and the interest on telegraph stock created in the year ended 31st March, 1886, £371,554 6s.

The total of the deficiency to the 31st March, 1866, was £2,553,009 13s. 6d. as shown below, viz.:—

	£	s.	d.
Deficiency for the year to 31st December, 1872 (*vide* Parliamentary Paper, No. 65 of 1877) ...	118,966	15	1
Deficiency for the year to 31st December, 1873 (*vide* Parliamentary Paper, No. 65 of 1887) ...	177,988	11	4
Deficiency for the year to 31st December, 1874 (*vide* Parliamentary Paper, No. 65 of 1877) ...	207,898	0	5
Deficiency for the fifteen months to 31st March, 1876 (*vide* Parliamentary Paper, No. 67 of 1877)	191,633	14	7
Deficiency for the year ended 31st March, 1877 (*vide* Parliamentary Paper, No. 30 of 1878) ...	187,259	0	11
Deficiency for the year ended 31st March, 1878 (*vide* Parliamentary Paper, No. 35 of 1879) ...	189,066	8	2
Deficiency for the year ended 31st March, 1879 (*vide* Parliamentary Paper, No. 61 of 1880) ...	114,119	12	5
Deficiency for the year ended 31st March, 1880 (*vide* Parliamentary Paper, No. 23 of 1881) ...	29,909	2	7
Deficiency for the year ended 31st March, 1881 (*vide* Parliamentary Paper, No. 47 of 1882) ...	984	7	3
Deficiency for the year ended 31st March, 1882 (*vide* Parliamentary Paper, No. 42 of 1883) ...	112,524	16	1
Deficiency for the year ended 31st March, 1883 (*vide* Parliamentary Paper, No. 51 of 1884) ...	142,223	10	8
Deficiency for the year ended 31st March, 1884 (*vide* Parliamentary Paper, No. 73 of 1885) ...	346,114	4	3
Deficiency for the year ended 31st March, 1885 (*vide* Parliamentary Paper, No. 60 of 1886) ...	362,767	3	9
*Deficiency for the year ended 31st March, 1886, as above	371,554	6	0
	£2,553,009	13	6

* Sixpenny telegrams commenced October 1st, 1885.

THE AUSTRALASIAN CABLE QUESTION.

A FEW months ago we (*Imperial Federation*) called attention to an official statement made in the House of Commons that telegraphic communication with the Australian Colonies had been dependent solely upon the line through Russia only once during the six years from 1881 to 1886. The deduction which every one was expected to draw from this was that interruptions were of the rarest occurrence, and that an alternative route was therefore unnecessary. Perhaps the following record of the cable interruptions on the Australian route between the years 1872 and 1883 (we are unable to furnish later figures) will show that it is living in a fool's paradise to believe that break-downs are few and far between. Indeed, it is only the fact of the line being in duplicate that has saved the communication from being constantly defective. We are unable at present to lay our hands upon the dates when the two lines between Singapore and Port Darwin were laid down, but we shall endeavour to discover this for the benefit of the public, who ought not to be allowed to remain in doubt as to the exact measure of their security. It is, however, a sufficiently serious matter when we find that in the twelve years under review there have been no less than 30 break-downs, totalling up to a period of about 540 days, or 18 months, during which some portion of the direct cable route to Australia was unavailable. We now give the list, leaving our readers to form their own opinion as to the entire trustworthiness of cable communication with Port Darwin, the only point, be it remembered, in Australia, which is connected with any other continent by cable.

CABLE INTERRUPTIONS ON THE AUSTRALIAN ROUTE, 1872—1883.

	When interrupted.	When restored.	Where between.
1872	June 22.	Oct. 20.	Port Darwin and Banjoewangie
1873	Feb. 21.	Feb. 24.	Land line between Boezki and Banjoewangie.
	March 31.	April 2.	Batavia and Singapore.
	May 12.	May 26.	Penang and Madras.
	July 13.	July 13.	Land line 30 miles from Banjoewangie.
	Nov. 20.	Nov. 23.	Singapore and Penang.
1874	May 20.	May 31.	Batavia and Singapore.
	Aug. 13.	Aug. 15.	Ditto.
	Aug. 16.	Aug. 23.	Ditto.
	Dec. 10.	Dec. 29.	Ditto.

Floating station was established 16 miles from Batavia, with daily steam communication to Singapore, on December 18th.

1875	Sept 2.	Sept. 16.	Batavia and Singapore.
	Nov. 5.	Nov. 8.	Ditto.
	Nov. 15.	Dec. 24.	Penang and Madras.
1876	March 28.	Aug. 24.	Ditto.
	April 24.	Aug. 7.	Port Darwin and Java.
	Oct. 22.	Nov. 30.	Batavia and Singapore.
1877	Feb. 26.	March 2.	Ditto.
	July 15.	July 17.	Singapore and Penang.
	Sept. 26.	Oct. 13.	Batavia and Singapore.
	Oct. 19.	Oct. 31.	Singapore and Penang.
	Nov. 8.	Dec. 15.	Port Darwin and Banjoewangie
1878	Jan. 22.	Feb. 3.	Batavia and Singapore.
	March 11.	March 13.	Land line between Sitoebondo and Surabaya.
	Sept. 26.	Oct. 5.	Port Darwin and Banjoewangie
1879	May 29.	May 30.	Ditto.
	July 4.	July 24.	Ditto.
1883	March 5.	March 7.	Ditto.
	March 9.	March 16.	Ditto.
	April 6.	April 9.	Ditto.
	Oct. 22.	April 26.	Ditto.

Supposing that cable communication between Port Darwin and London were absolutely perfect, and secured against the faintest possibility of a break-down, there would still be cause for the gravest anxiety, should it be a matter of urgency to send telegraphic despatches to our great Australian Colonies.

It must be remembered that the whole continent of Australia has to be traversed by a single line before that network of telegraphs in the south is reached, where total interruption is a practical impossibility. The nearest telegraph station in Queensland is several hundred miles from the trans-Continental line over which every message from Europe to Adelaide, Melbourne, Sydney, Brisbane, and New Zealand has to pass.

It is sometimes supposed that a land wire is perfectly safe. So far as the Queen's enemies are concerned this is true; but there are natural forces which give more trouble than hostile grappling-irons. Between Port Darwin in the north, and Port Augusta, where the branches diverge from the trunk line in the south, there have been in the 12 years, from 1872 to 1883 inclusive, 100 separate occasions on which communication has been interrupted, covering a period of 201 days.

What, then, is the use of relying upon duplicate cables and security of communication by sea, so long as these interruptions take place on the land? Some of the stations are very long distances apart, and priceless time might elapse in conveying some urgent message across the hiatus caused by a break-down. Is it not the height of infatuated folly to lean upon the fancied safeguard of this transcontinental wire, which has so often failed us? It is admitted on all hands that *immediate* notice of a declaration of war would be a necessity if the shipping in Australian waters is to be confined to port, and the harbours are to be protected against attack. And yet the only means of sending prompt information to a single port in Australia or New Zealand hangs upon the immunity from damage of a single line of telegraph, which can only show for a testimonial the record of 100 interruptions in 12 years. The list is too long for us to publish the whole of it; but we append a summary, which shows that the break-downs can be reckoned upon to occur in every year, to a greater or less extent.

INTERRUPTIONS ON THE TELEGRAPHIC LINE BETWEEN PORT DARWIN AND PORT AUGUSTA.

Year.	Number of times broken.	Total length of interruptions.	Year.	Number of times broken.	Total length of interruptions.
1872	2	6 days.	1878	19	38½ days.
1873	7	18 days.	1879	13	22 days.
1874	8	20 days.	1880	2	2 days.
1875	8	17½ days.	1881	5	5½ days.
1376	9	25 days.	1882	5	6½ days.
1877	17	34 days.	1883	5	6 days.

We hardly know where to look for comfort—whether the cables or the land-line are most to be trusted. But surely the case is strong enough to be taken in hand without delay. Many millions sterling are hazarded on this question of rapid and secure communication with Australia. Merchants in London are concerned in it, no less than in the Colonies; and if the Imperial Conference is allowed to meet and disperse without a definite course being adopted to remedy the dangers of the situation, a very grave responsibility will be attached to every member of it, who having the opportunity, has failed to lift up his voice in earnest protest against the neglect of so vital a matter.

THE ECONOMY AND EFFICIENCY OF UNDERGROUND ELECTRICAL CONDUCTORS IN CITIES.

By DAVID BROOKS.

WHEN Mr. W. H. Preece, the chief electrician of the English Post Office Department, was in this country two years since, he stated that whenever the Government could get as many as 15 electrical conductors into one route or channel, they found it both advantageous and economical to place them underground. Mr. Preece's experience with underground electrical conductors, as compared with overhead conductors, was almost entirely with the underground conductors insulated with gutta-percha.

The cost of a No. 18 British gauge wire, insulated with gutta-percha, according to the Government standard, is about $75 per mile. These conductors are drawn into cast-iron pipes, usually buried beneath the sidewalks at an average depth of two feet below the surface. This is the cost of the conductors themselves; but the expense of the trenching, the iron pipes, the drawing-in and splicing, brings the cost of these wires when laid to $100 or over per mile. Gutta-percha insulation is expensive.

By the use of oil, and a textile covering for the wire, instead of the gutta-percha insulation, we can lay three times as many of those conductors in this country for the same amount of money. In Europe we can lay at least five times as many conductors of the same gauge for the same expense.

Durability.

The next question for consideration is the comparative durability of the different systems. Gutta-percha or India-rubber, like all vegetable or organic matter, undergoes disintegration and decay, but much depends upon the condition in which it is used. As it is used in England, it lasts from seven to ten years. It is exposed to the influence of damp and impure air. The French use the same kind of insulation, but they draw from five to seven conductors into a lead pipe, which is afterwards pressed tightly around the group of conductors, so as to exclude the air; and by that means they have made the insulation last 30 years; so I was informed in 1881 by the French electrical engineers;

and for all I know those conductors are working yet. Within the last few years they have laid a large amount of those lead-covered cables, drawn into cast-iron pipes of larger diameter, and have wires working now underground from Paris to Marseilles and other cities of the Republic. Gutta-percha, when buried in the sea, and away from the influence of the air and the light, is said to be practically imperishable; but when suspended in the Paris sewers, and unprotected by the lead covering, it lasts but a short time.

The life of an insulator is dependent upon its durability. As a gutta-percha insulating material goes into decay, it does not become a conductor of itself, but it cracks and then admits moisture, and the moisture in the cracks becomes a conductor. Conductors insulated with India-rubber made from old shoes has every appearance of presenting as high an insulation as those insulated with fresh Para rubber; but the life of the former is comparatively short as an insulator, because the material itself has lost its vitality.

There are different methods of preserving materials of all descriptions, but as a general thing almost any organic matter and the metals can be preserved if we protect them from the effects of light, heat, moisture, and the air. As a rule, heat is not a factor in the decay of electrical insulating materials, for, as commonly used, they are not subjected to the influence of abnormally high temperatures.

I insulate underground wires with oil and a textile covering. All traces of moisture, air and light are excluded. There is nothing that can in any way affect the contents of the pipe. The textile covering is preserved by a hydro-carbon, the most stable of all materials, the same that has preserved the linen covering of the Egyptian mummies for thousands of years. The hydro-carbon preserves the inner surface of the pipe, the copper conductors and their covering. No change can take place in the condition of those materials, and, as a consequence, no change can take place in their insulating properties, as the insulation is entirely dependent upon the durability of the insulating materials; or, in other words, the durability is more a question in physics than an electrical question. If I were asked how long a glass insulator would last, I would say just as long as the glass remains whole and entire. I am often asked if the electrical current does not affect the oil. I say, no more than it affects the glass insulator on the poles. Such non-conductors as glass or oil, or any other equally good insulators, are unaffected by a current of electricity.

This much relates to the inner surface of the pipe and its contents. The outer surface of the iron pipe is protected from rust by being enclosed in a wooden box of sufficient dimensions to contain the iron pipe and a concrete covering composed of pitch and sand, which effectually prevents oxidation of the outside surface of the iron pipe. Under these conditions the system can be said to be indestructible except by mechanical means. So much for durability.

The Ease and Facility with which the System is Laid.

As much as 2,000 feet of trench have been dug, and the lengths of iron pipe screwed together, and the trench filled and repaved in one day. The inside of the pipe having been scoured and polished perfectly smooth, 2,000 feet of cable can easily be drawn in. The oil acts as a lubricator, enabling the cable to slip along easily and without friction. Nor is it necessary that the pipe be laid in a straight line. We go either above or below gas or water pipes, or to one side or the other of any obstruction we meet.

Three 3-inch diameter pipes, with carrying capacity of 1,530 conductors are laid in Calhoun Place, Chicago. The wooden box containing these pipes has less than one square foot of section. A mile of cable could be drawn in, in one length, if it were desirable.

By having a short piece of the pipe bent so as to form a 90° segment of a circle, the radius of the circle being two feet, street corners can be turned with ease, and cables have been drawn around two of such corners without producing a sensible or material increase of friction. By the use of the splice boxes, or hand holes, as many as 500 splices have been made by one person in a day. In New York, hand holes were inserted every 45 feet, making it easy to bring out conductors and lead them into adjacent buildings; and they are so introduced, every portion of the wire from the building to the exchange being underground. Of those 800 conductors now in use for two years, not one has failed or cost one penny for maintenance or repairs. Another method is to bring out under the sidewalk, through the cellar to the rear of the building, as many conductors as will be needed in that block. They can be distributed from a short pole easily to any or every building in that block. A property owner would sooner grant this privilege than have poles standing in front of his building, as such poles must necessarily be high, and the snarl of wires radiating from that structure presents a very unsightly appearance.

For Telephonic Lines.

The system is peculiarly adapted for telephonic purposes, being free from inductive disturbances and overhearing or eavesdropping. Those having interests in telephonic exchanges should consider the advisability of applying a portion of their earnings to the placing of the conductors underground. They should take into consideration the expense they are now under of having so large a force employed to hunt up and remove "trouble," and the vexatious annoyances occasioned by the frequent interruptions of the overhead service. The outlay incurred in maintaining the force simply to remove "trouble" would pay an interest on a very large amount of capital. They should take into consideration that these overhead conductors are getting weak and brittle from exposure to the atmosphere of cities. The main telephone patent will expire in a little over six years. During this time, with judicious management their conductors can be buried, and the expense of this work paid out of the earnings of the company. A stockholder would part with his stock while it is paying 12 per cent. at a less price than he would were it paying 6 per cent., if he knew that when the time arrives for the patent to expire the conductors would be underground, and the expense of putting them were paid. Would a competing company easily raise the funds to put down a plant to compete against a company whose plant is already down and paid for? It is evident that the present companies would be as well protected under these circumstances from competition as they are now by the patent itself.

It is also well to bear in mind that since electric lighting came into use many of the telephonic exchanges and telegraph offices have been either destroyed or seriously damaged by fires occasioned by electric light conductors coming in contact with the telephone or telegraph conductors, and this danger will continue so long as these different electric conductors remain overhead. In New York, Brooklyn, Philadelphia, and other places, people have been killed by coming in contact with electric light conductors. Chicago is the only large city that has not suffered in this respect, and the reason is that all the electric light conductors are underground. Chicago is in advance of all other American cities in this underground business. Chicago has one-third more telephone subscribers than Philadelphia. The Bell Telephone Company, of Philadelphia, employ twenty more men than the Chicago Telephone Company to remove interruptions to their circuits. The Philadelphia Company have no wires underground.

For Telegraphic Lines.

For telegraphic purposes few are aware of the advantages of having the wires placed underground in cities. The glass insulators in cities soon become coated with soot or carbon, and thousands of insulators are in use that will not show an insulating resistance of one megohm. There is as much loss of current over one insulator so situated in rain and dampness, as there is in 20 miles of the line in the country, where the insulators

are clean and affected by moisture only, which is comparatively free from impurities. When lines are worked upon the same set of poles with positive and negative currents, the interference from wire to wire by these batteries short-circuiting into each other, commonly called cross-currents, is so great that some of the circuits have to be opened in order to enable the others to be worked. The telegraph officials in Chicago all speak of the great advantage derived in this respect from having their wires placed underground in that city.

For Electric Lighting Wires.

For electric lighting this system is peculiarly well adapted, both for arc and incandescent. By the use of these splice-boxes and hand-holes the conductors can be brought into the buildings for house-to-house purposes, or into the ordinary street lamp-posts. The conductors for such purposes can be drawn in singly or a number of them in a group, as circumstances may require. Oil is the strongest insulation known, or least liable to be affected by currents of high potential and quantity combined.

Underground Conduits.

Underground conduits first began to be invented in England about the year 1850, and from that time until 1860 many patents were taken out for different forms and materials. But a great many patents have been taken out in this country within the past ten years for that class of inventions. Neither in England nor in this country have the patentees been known as having much or any electrical experience. These various patented conduits are supposed to facilitate repairs by easy drawing in and out. From the nature of the case, conductors placed in these receptacles are continually in need of repairs. The atmosphere of the conduit is full of gases that will soon affect and destroy anything that is put in them. Some of the gases are heavier than the air, and their tendency is to collect and stay in the conduit. They act upon the metals, lead and iron like stagnant water, and no insulating covering of any kind can long withstand the effect. They are always damp, and the inner surface so wet that nothing is gained by having the material of the conduit itself made of a non-conducting substance.

It has been proposed to make these conduits of wood, but such a structure decays very rapidly, as was shown in the early experiments in England. A piece of wood buried in the ground, with the earth packed closely around it on all sides, lasts ten times as long as a wooden box containing damp and impure air. The decay begins on the inner surface of the box, that portion of the box coming in contact with the impure air, and no means have ever been devised to prevent it.

The writer has spent the last four months in Chicago and has had abundant opportunity to examine the different systems there. That of the Dorsett has fewer conductors and in much shorter lengths than I laid for the Metropolitan Telephone Company, in New York, two years ago, which has not cost one cent for repairs nor have any of them failed or deteriorated. But in Chicago, although the conductors have been in the ground a shorter length of time than have those I laid in New York, three men are continually employed, in Chicago, in repairing and removing faults or interruptions. The lead covering is often eaten through by rust.

They dare not go near the manholes with a fire or soldering pot for fear of explosions. I had myself an experience. The Chicago Telephone Company had arranged a manhole for bringing in the wires, opposite No. 91, Jackson Street. When we sent a man into the manhole with a lantern, to splice the wires, an explosion took place, which set fire to the covering of the wires. In order to put out this fire, snow was shoveled on and by that process they got water into the pipe, which delayed our work two days.

A galvanised wire drawn into one of these conduits six months since, when pulled out showed no traces of zinc covering, it having been so affected by the atmosphere of the conduit.

Another objection to these conduits is their cost. I can lay alongside the conduit put down on Sixth Avenue, New York, an equal number of conductors that can be got into that conduit, the conductors being of equal insulation and conductivity, for less money than the conduit costs, without wires in it. And I will guarantee the interruptions or failures from every cause to be less in the conductors I lay than those in the conduit, in the proportion of one to 100.

Lead-covered Cables.

A lead pipe of sufficient diameter to contain 100 conductors, costs as much per foot as an iron pipe containing 500 conductors. If as many as 200 conductors can be got into one route, it costs no more to place those conductors underground in an iron pipe than to string them overground in lead pipes, and in the latter position they are liable to injury from fire, as almost every telephone exchange using lead-covered cables can testify. If lead-covered cables are placed underground they have to be imbedded in asphalt or pitch, to protect the lead covering, and in case of an accident happening to the conductors it is extremely difficult to find and remedy the trouble.

The lead covering is seriously affected, as before stated, by the atmosphere of the conduit, and lead-covered cables are extremely unwieldy to draw out of a conduit.

In our system, the cables can be easily drawn out of the iron pipes if occasion demands it. We have only had one such occasion and that was in Chicago, when it became desirable to substitute a 250-wire cable for one which had only 150 conductors in it.

The London *Electrician*, of May, 1886, contains the following experiments with oil as an insulator, by H. C. Frempt :—

"The oil used to insulate the underground wires running into the telephone exchange, at the corner of Broadway and Spring Street, New York, is heavier than water. Take two cotton-covered wires which have been boiled in that oil, draw them through glass tubes, twist the ends together, and place them in an ordinary glass battery jar. Fill the jar half full of oil, after which water may be carefully poured into the jar and it will remain above the oil. Attaching the poles of a battery to each of these wires, as shown above the glass tubes, no current will be observed as passing from one wire to the other.

"Take a piece of lead pipe containing a cable of cotton-covered wires insulated with the same oil in a fluid condition, and cut a hole in the lead an eighth of an inch in diameter. The oil being viscous will ooze out slowly. Place the cable in a jar, and fill the jar with water, the oil will continue to flow till an equilibrium is established, but no current can be passed from one wire to the other or from either wire to the lead pipe. Now, if instead of oil we use in this experiment paraffin, pitch or resin, the insulation immediately fails.

"Six years ago since there was a lead-covered cable insulated with oil, armoured and laid across the Delaware River. The cable contained 50 conductors, not one of which has failed. The cost of this cable of 50 conductors was no more than that of an ordinary gutta-percha insulated cable of five conductors. The gutta-percha insulated cables across the Delaware during this period has been continually subject to mishaps. Many of the conductors have been injured by lightning, although protected by lightning arresters. When the gutta-percha insulation is punctured by atmospheric electricity, it leaves a hole in the insulation in which water enters, by which the current passes to earth. The cable has to be under-run, the leak found and the hole sealed up, but a hole cannot be made in a liquid."

The splice boxes we use will hold two gallons of oil after the splices are covered with oil. When the splices are covered by the oil we can fill the remaining portion of the box with water without affecting the insulation of the conductors.

Philadelphia, *February 15th*, 1887.

ELECTRIC LIGHTING ACT (1882) AMENDMENT BILL.

HOUSE OF LORDS, TUESDAY, MARCH 1ST.
(*From the "Times."*)

Lord THURLOW said that in asking their lordships to give a second reading to this Bill he desired to say that its subject was not new to him, as he had for the last five years been practically and commercially connected with the industry, and had for four years been one of the few members of their lordships' House who had had electric light in his own house, and thus had daily opportunity of studying it and of appreciating its comfort and convenience. It would be interesting to know how many of their lordships actually had introduced electric lighting into their houses. He should think a dozen or a score would be the outside. Among them, however, there was, he was glad to say, the leader of the House, the noble marquis the head of the Government, who had the honour of having been one of the earliest and most successful pioneers of electricity, not only in connection with lighting, but with the transmission of power. He could not help thinking that the experience of the noble marquis would make him concur with him in thinking that the moment had now come to amend the Act of 1882, under which, as it stood, central lighting stations and house to house lighting were a commercial impossibility. Their lordships must remember the circumstances under which that Act was passed. The science was then in its infancy. Not long before Lane-Fox and Edison had made discoveries in filaments and attachments that had for the first time made incandescent lighting practically possible. Electric lighting then rapidly became a medium for the heaviest gambling in shares known since the South Sea Bubble. So great was the notoriety of this gambling that the Government of the day felt bound to step in to prescribe rules for regulating and arresting the flow of capital into all kinds of hasty and ill-considered schemes. All this had now completely changed. The gambling spirit that raised £5 shares to £60 had passed away and been buried in the ruins of many of the companies which were then promoted, and the stage of leisurely repentance had been reached. Meanwhile, immense progress had been made in every branch of electric lighting. One branch of the subject, almost unknown in 1882 and now justly considered as a necessary element in successful incandescent electric lighting—namely, cells or accumulators for storing electricity—had now been practically perfected. Without storage batteries engines and dynamos must be kept constantly working, and the light, which flickered always more or less with the pulsations of the engine, was injurious to the eyesight and unsatisfactory. Of course, much work remained to be done. Reliable and simple meters were still required, but the position had quite changed. Electric lighting was no longer a dream of the future but a reality, and commercially possible but for the Act of 1882. For example, ship lighting, subjected to no trammels, was now being universally adopted by all the great companies, the Cunard, the P. and O., the German Lloyd, and by the navies of the world. Even great buildings large enough to make them independent of central lighting stations and able to generate electricity for themselves had adopted it, such as Buckingham Palace, the Grand Hotel, the Métropole and First Avenue Hotels, several theatres, the Athenæum Club, the Junior United Service Club, the Junior Carlton, South Kensington Museum, the British Museum, the Grosvenor Gallery, and many more; but house-to-house lighting remained an utter impossibility, as capital could not be raised under the onerous provisions of the Act of 1882 for central lighting stations. Let their lordships compare with this state of things the position of the science abroad and in America, where it was estimated that upwards of £32,000,000, of which £21,000,000 were in arc and £11,000,000 in incandescent, had been invested in electric lighting. To come, however, to the Bill before the House, their lordships would remember what passed on the subject last year, when three Bills were introduced. For Bill No. 1 he was himself to a large extent responsible, as it was the Bill of a committee of experts and scientific men who had considered the matter for two years and over which he had the honour to preside. That Bill aimed, no doubt, at too much. Its object was to put electricity on the same footing as gas. This was considered as a desire to set up a second monopoly, while the real object was only to enable it to compete successfully against an existing monopoly. Bill No. 2 was brought in by a noble viscount not now in his place (Lord Bury), whose knowledge of the subject was accurate and extensive, and Bill No. 3 was the Government Bill. Those three Bills went to a Select Committee, and important evidence was heard, among others that of Sir F. Bramwell, Mr. Preece, Mr. Forbes, Mr. Hucks Gibbs, Mr. Cohen, and Mr. Crompton. The result was the amendment of the Government measure, Bill No. 3, and in that amended shape it would have passed into law had it not been for the change of Government and death of the Parliament. The present Bill was founded on that Bill with only one addition. It was last year's Bill No. 3, as amended in Committee with "good-will" added. It only amended the Act of 1882 as regarded clause 27, which dealt with the compulsory purchase of an undertaking by a local authority. The clause as it stood had been irreverently called the "old iron clause," because under it property was to be compulsorily bought at its break-up value irrespective of its value as a going concern, after only 21 years. The effect of that was to compel undertakers to charge such a rate for electricity as was practically prohibitive and prevented its competition with gas. On this point he must confess to holding strong views, and he could not see why this industry should be treated differently from any other in the event of compulsory purchase by a local authority. Indeed, it had some claims to almost preferential treatment on account of salubrity, cleanliness, and safety. It seemed to be only a question of an alternative—either to allow a fair valuation of goodwill of the business or to grant the licence for such a prolonged period as would enable undertakers to recoup themselves without charging a prohibitive price. If 50 years were granted this might meet the case, but on the whole it seemed wiser to shorten the preferential term and to provide for competition at its expiry. This was the only question really to be settled. All were agreed on other points, such as the lamps clause, continuous supply, &c. The goodwill question was a thorny one, and admitted of much being said on both sides. His desire was to place it before the House as an open subject for the House in its wisdom to decide. He was willing to accept any reasonable amendments in Committee if the House would permit the Bill to be read a second time, and he was willing to postpone the Committee stage to any reasonable date to suit the convenience of the Government and to afford time for deliberation. His only desire was that legislation should proceed this Session, and that an industry which only required fair conditions to progress should, in these days of depression and of large armies of unemployed, go on for the good of trade and of mankind at large. His object was to come to the relief of an industry capable of rendering the most important services to civilisation. His own belief was that before many years they would find the Board of Trade prescribing electric lighting on the score of health and safety in all factories, schools, mines, theatres, churches, and the like; that the gas companies in England would follow the example of the gas companies on the Continent and in America, convert their plant and become purveyors of electricity; and that finally registrar-generals of the future would be able to trace to this cause increased immunity from consumption and other kindred diseases which infallibly arose to a great extent from vitiation of the atmosphere now breathed. He could only say, in conclusion, that if the Government would undertake to deal with the matter, he would gladly leave it in their hands, and that he was willing to consider all points open to fair consideration in committee if their lordships would accept the view he took of the desirability of speedy legislation, and allow the Bill to be now read a second time.

Lord HOUGHTON said that no doubt the Bill of the noble lord was founded on the Government Bill of last year as it emerged from Committee; but there were two particulars in which it differed from that Bill—one of addition and one of omission in regard to the powers of the local authorities. The first referred to the veto the local authorities might exercise when companies applied for a provisional order. This Bill provided that local authorities should have nothing less than a veto upon any undertaking in their district. He would suggest that when a local authority objected to a lighting scheme the matter should be referred to the Board of Trade, and if it saw ground for refusing the application it should make a special report to Parliament. He hoped that this suggestion would be considered by the promoters of the Bill. On the question of the terms on which an undertaking should be acquired by a local authority, he should await with interest the expression of the views of the Government. He hoped the Bill would be read a second time.

Lord LINGEN was understood to say that the interests of a local authority entitled it to favourable consideration, and pointed out that in the case of Dover Harbour their lordships had given a second reading to a Bill which proposed to give to a corporation some powers over a public harbour. There were two classes of witnesses before the Select Committee, and one class, which included town clerks, objected to local authorities paying for goodwill.

The Earl of CRAWFORD and BALCARRES said that he thoroughly supported the second reading of the Bill, and approved the payment for goodwill on the compulsory purchase of a successful undertaking. No doubt some consideration should be made to local authorities for the permission they had granted to companies to carry out their works, but it should not be more than was just and equitable. It was worth consideration whether an arrangement could not be made for the payment of a rent by companies to local authorities. If the undertakings of electric lighting companies were to be taken without payment for goodwill, he did not see where appropriation would end. It might be extended to gas, water, and steamship companies, whose undertakings were all matters of public importance. The attempt to put electric lighting on a new footing ought to be checked at once. The subject of electric lighting was one which he had cherished for a long time, and he believed it was now in a position to stand alone, provided it had a fairer chance than it had when the legislation was introduced. Therefore he did not greatly believe in the Act of 1882. He thought that Act had kept back the use of electric lighting.

Lord BRAMWELL said he was a member of the committee which sat on this subject, and one thing was quite certain, that legislation on this subject was necessary. Electric lighting was now a success which could be relied upon. Whether it could beat gas was another matter, but as a light it was a success. At present, however, it could not be got by the public on account of the terms as provided by law. As the law now stood the terms were very hard indeed. It was that at some time or other—at the end of 20 years, or 30 or 40 years—however prosperous the concern might be, it was to be bought, not upon the terms paid for a successful concern, giving compensation for the employment of the capital

in what might have been a failure, but it was to be bought according to the value of the plant and property belonging to the undertakers. It had been said that those were fair terms, but capitalists said "We do not think so; we shall not subscribe on those terms," and it was in vain to tell them that they ought. The consequence was there was no electric lighting. He was not going to find fault with the Board of Trade, its changing head or the permanent staff. He thought they ought to do their best for the public; but, unfortunately, they had imposed such terms as to put a stop to it altogether. Therefore he said some legislation was necessary. He trusted their lordships when the matter came before them would take a much more reasonable view of the subject than the local authorities.

The Marquis of SALISBURY said in the absence of his noble friend the President of the Board of Trade, he did not like the subject to drop without saying something on behalf of the Government, but after the speech of the noble and learned lord opposite there was really very little to say. He thought the noble and learned lord had presented the case with absolute fairness, but he wished to clear himself of the charge which the noble lord on the front Opposition bench seemed inclined to level against those who supported the Bill. He had never himself been bold enough to have a single share in any of the electric lighting companies. He was looking at the matter as a public question, and he had no interest in it, and never expected to have, except as a means of promoting a product of public utility. The history of this case was really the history of the action of a public department. The Board of Trade was horrified, and intelligently horrified, at the position in which Parliament found itself in respect to the water companies. It was not entirely satisfied with the position in which Parliament found itself with respect to the gas companies. He did not say that that feeling had so much plausibility as the other. But the Board seemed to have resolved that it would not allow Parliament, as representing the public, to fall into that difficulty again, and that it would take good care that when electricity came for its authorisation to Parliament terms should be arranged which would place the public in a much better position than they were in with regard to the gas or water companies. But their very natural and praiseworthy feeling was carried to an exaggerated point. Their precautions were excessive. The legislation passed in 1882 had absolutely stifled the enterprise of those who wished to introduce the electric light into this country, and they were now in this position—while in other countries the electric light was used for public purposes, it had not been used in this country, and could not be used, except by those companies or institutions or persons who could have the whole machinery for their own use and produce their electricity entirely for themselves. He could not imagine that Parliament could look on this as a desirable state of things. Why were they not to have the comfort and advantage of this light, which those who were in a position to use it showed an increasing desire every day to have. The only argument which had any plausibility—and it was an argument which appeared to prevail in the minds of many noble lords—was that they would save the rates of local authorities in this matter. He did not dispute that this was a very suitable matter for the local authorities to undertake if they were willing to do so, and he could quite imagine that in 1882 the Board of Trade and the local authorities, generally speaking, thought it would be a pity to allow companies to step into their place. But five years had passed away, and the local authorities were not inclined generally to take this enterprise up. They were really putting the local authorities in the position of the dog in the manger; they would not allow the companies to enter upon an enterprise which they would not undertake themselves. With respect to the noble lord (Lord Lingen) who had cited the case of Dover harbour, he would point out that the two instances—that of the electric light and Dover harbour—were not on all fours. If the Town Council of Dover had come to their lordships to claim liberty to fill Dover harbour up and shut it up until such time as it should be convenient for them to open it themselves, then they would have been in exactly the position of the local authorities now who wished to stifle all electric lighting enterprise until they saw their way to undertake it themselves. He did not think that that was a proposition which Parliament ought to support. He inclined, in spite of the terror of the example of the gas and water companies, to go back to ideas of less restriction and greater freedom in this matter, and to allow enterprise to have its full swing, to remove the obstacles which had hitherto impeded it, and to offer terms, not such as they thought the capitalist ought to accept, but which they found by experience he would accept. So it might be possible by giving rights which were generous and large, to procure for the public the full advantage of those scientific inventions which other nations had, and which now, by our restrictive policy, we prevented the public from enjoying without doing any good to the local authorities which were the subject of so much tender care.

Lord THURLOW said he would endeavour to amend the Bill in Committee with the object of meeting the views which had been urged.

The Bill was then read a second time.

Electrical Power from Niagara Falls.—We (*Times*) are informed that an English syndicate has secured the charter granted by the Legislature of the State of New York for utilising the water power at Niagara Falls for manufacturing and electric lighting purposes.

REPORT ON THE INSTALLATION AT THE PRINCE OF WALES'S THEATRE, COVENTRY STREET, W.

By E. L. BERRY.

I HAVE great pleasure in placing before you for publication in your Journal, the third year's report of the working of the above installation.

The plant comprises a 12 H.P. Clark's gas engine, manufactured by L. Sterne & Co., 1 Siemens D_1 dynamo, an E.P.S. battery of 53 cells, and 360 Swan lamps, 108 volts 16 C.P.

In placing this report before your readers, my firm must candidly express the great satisfaction the gas engine has given ever since its erection. During the past year it has run 2,895 hours. The only repair that the engine has had since erection is the annual cleaning of the water jacket on account of the deposit of lime which we find comes from the circulating water. The other repairs have been trifling. The slide now working was put in in June, 1885, and has not been refaced. The bearings have not been touched; the latter no doubt is helped by using nothing else than castor oil, which we consider best for heavy bearings.

The engine, besides running the dynamo, also drives the pumps for the hydraulic machinery for the iron fire-proof curtain on the stage, and for the hydraulic lift. The dynamo has this year been more satisfactory than the last, only six pairs of brushes being used, and it has only been turned up once, and has not given any trouble whatever.

With regard to the accumulators, the glass cells which were put in about 18 months ago are still working well; only seven of them have had to be taken out and the plates straightened; although put to very heavy work the remainder are in capital condition. In October last 24 of the old teak boxes were taken away and replaced by 48 glass cells; these have all worked admirably, being now in splendid condition and showing a fine dark chocolate colour on the positive plates; the negative plates only show a very slight appearance of blistering.

The lamp renewals show a larger average than before, owing greatly to a number of old lamps giving out their life. There are several lamps still running that were put up when the theatre was built, and have stood the greatest work, and are still working, having run over 3,500 hours.

During the year we erected a batten with 12 lamps under the painting-room floor which overlaps the stage, and 8 lamps under the stage, gas being found too hot and the men being unable to work, there being very little ventilation there.

These lamps are greatly appreciated by those working under them. The renewals are as follows:—

Loops 31; accidents 21; filaments 70; total 122. Of these we have been able to repair 28 lamps of the broken loops. The theatre was closed three weeks in July, but there have been 46 morning performances.

Subjoined is an abbreviated account of the working expenses:—

Electrician and assistant	£221	2	6
Gas used by engine	189	4	0
Lamps	25	5	0
Oil for engine, shafting, dynamo and pumps	8	8	0
Waste for above, and sundry other purposes	1	15	0
Six pairs of brushes	1	17	6
Lamp shades	0	9	6
Sundries	4	0	0
	£452	1	6

Repairs:—			
Accumulators	£186	0	0
Dynamo	0	12	0
Engine	4	4	0
Belts	4	10	0
	£195	6	0

Total for working	£452	1	6
„ „ repairs	195	6	0
	£647	7	6
Total for two previous years ...	£1,131	5	10
Grand total for three years ...	£1,778	13	4

Certificate from E. Bruce, Esq.
Prince of Wales's Theatre,
March 2nd, 1887.

Another year is now completed, making the third since the electric light was installed at my theatre, and again I have nothing but praise to give to those concerned for its very successful working; in no instance has it failed. I have made further use of it on the stage for lighting effects in "Alice in Wonderland," and am thoroughly satisfied at the results obtained.

(Signed) EDGAR BRUCE.

NOTES.

Electric Lighting in the Navy.—The contract for fitting H.M.S. *Hero* at Chatham Dockyard with 253 incandescence and four search lights, has been placed with Messrs. Goolden and Trotter, of Westminster. The work, which was commenced on Monday last, will be carried out under the direction of Mr. R. A. Scott, their ship-lighting engineer.

Electric Lighting in Windsor Castle.—The electric light which was introduced some time back into several of the State apartments at Windsor Castle, says *Truth*, has now been extended into the residential portion, and the grand corridor, the three drawing-rooms (the white, the green, and the crimson) the great dining-room, and the oak room are all fitted with it. This improvement has been brought about by Sir John Cowell.

Further Extension of Electric Lighting.—We hear it reported that boilers have recently been purchased representing 1,000 horse-power, for use in a London central station. This probable development of electric lighting is said to have no connection with the schemes which are already under weigh.

Electric Lighting in Belgium. — The Brussels correspondent of *Industries* states that the new management of the Collieries de l'Ouest of Mons has installed a system of incandescent lamps for lighting the pit head workings. This is the first employment of electricity in this district, where there is considerable delay in adopting novelties. M. Pieper has obtained the contract for lighting the new Conservatoire of Liège; this will be carried out by his system of arc lighting. Two Fétu and Deliege double-cylinder gas engines, each of 20 H.P. will be employed. The lighting of the Liège Park has been entrusted to the Société Electricité et Hydraulique, of Charleroi. The power of the lamps in the Grand Place of Brussels is to be increased, so that they will illuminate the frontage of the Hotel de Ville, instead of merely the ground.

The Electric Light and Coast Defence.—The War Department authorities have ordered powerful electric search lights to be fitted on the fortifications at the entrances to the rivers Thames and Medway.

Lighting Lanark from the Falls of the Clyde.—An enthusiastic meeting of the inhabitants of Lanark was held last week for the purpose of obtaining an expression of public feeling on the proposed scheme to utilise the water power of the Stonebyres Fall for generating electricity. Provost Lamb presided. He was supported on the platform by a number of members of the Town Council and other local gentlemen. A resolution was passed strongly approving of the scheme as one that would be of great material benefit to the district, and a very influential committee was appointed to communicate with the proprietor on the north side of the river, who had not hitherto seen his way to come to terms with the promoters. The proprietor on the other side has come to an arrangement on the subject.

Litigation against Electric Light Companies.—The development of central station lighting in Paris is seriously threatened (*Industries* states), even before it has properly begun, by two lawsuits, one against the Eden Theatre, and the other against the Nouveau Cirque, which latter is situated near the Madeleine. In both cases the neighbours sued the companies for causing a nuisance by the noise and vibrations created by the machinery, and it seems probable that the establishment of central stations in the most fashionable quarters of Paris will become impossible if such litigation should become the rule. In that case, some system of long distance transmission by the use of transformers would be the only means of electrically lighting the better districts of Paris.

Lighting a Gunpowder Factory.—The War Office authorities have arranged that the Royal Gunpowder Factory at Waltham Abbey be lighted with the electric light, and workmen are now engaged in laying it on.

Litigation and Theatre Lighting.—The installation of arc lamps outside the Comedy Theatre is temporarily stopped pending litigation between the lessee and the ground landlord.

Theatre Lighting. — Mr. E. L. Berry, of Messrs. Berry & Co., has kindly forwarded to us the report of the third year's working of the electric light at the Prince of Wales's Theatre, formerly known as the Prince's. How satisfactory is the lighting may be judged from the testimonial of the lessee, Mr. Edgar Bruce, which accompanies the report.

Electric Lighting of Flour Mills.—The extensive flour mills and premises belonging to Mr. J. M. Bird at Lynn, have just been satisfactorily lighted by Mr. Wilson Hartnell, of Leeds, who seems to have made a special feature of this kind of work. The intallation consists of a 4 H.P. Gippeswyk vertical engine fitted with Hartnell's patent governor, driving direct by belt from the flywheel at a speed of 190 revolutions per minute on to a No. 2 Crompton compound-wound wrought iron dynamo, capable of driving 90 glow lamps at a speed of 1,100 revolutions per minute. Only 60 lamps are at present in use, these being of the Edison and Swan type, suspended by incombustible flexible leads from the ceiling.

Electric Light for Constantinople. — Continental advices state that a provisional convention has been secured by Messrs. Shippey Brothers, of London, for the exclusive supply of electric light and power to certain districts in Constantinople for a term of 50 years. The contract will be carried out under the auspices of Shelton Bey, acting for and on behalf of a very influential Turkish syndicate, which has been formed in Constantinople to introduce the electric light into Turkey, where it appears gas ranges from 8s. to 12s. per 1,000 feet, which, with coals at 20s. per ton at the port, should leave a good margin of profit for those interested in this important undertaking.

Electric Lighting in Derry.—The first attempt to introduce the electric light in the city of Derry was made a week ago by the Gülcher Electric Light Company, whose representative, Mr. A. J. Baron, erected on the premises of Mr. Shannon, plumber and gas-fitter, in Waterloo Place, an installation consisting of a Gülcher No. 1 type, low tension dynamo, one 3,000 C.P., and one 2,000 C.P. arc lamp, and 15 incandescent lamps of 20 C.P.

Electric Lighting Experiments.—On the evening of Monday last week, some interesting experiments with the electric light were conducted on the Blackpool Promenade, under the superintendence of Mr. William Chew, jun., of the Blackpool Corporation Gasworks. The *Gas World* states that for the past eight years the Gas Corporation of this favourite watering place has supplied both gas and electricity for public lighting. In this respect it has been more enterprising than many other corporations, but then Blackpool is exceptionally situated, and its prosperity as a borough depends to a large extent upon its attractions for visitors. When yet a novelty, the Corporation got Parliamentary powers to spend a large sum of money in experimenting with the electric light. It has spent liberally, and yet it does not seem settled as to which lamp it should adopt. Several of the newer patterns of electric lamps were experimented with this week, some of which it is said, burned for a period of 32 hours. Mr. Chew's report upon the experiments will be awaited with interest.

The Bournemouth Lighting.—With reference to our note last week, Messrs. Mortimer and Shepherd inform us that there is no hitch of an insurmountable nature in the proceedings which have been entered into for supplying the electric light in Bournemouth. The delay has been occasioned by matters which have reference only to the patents covering the apparatus to be employed. The plant will include some novelties of a practical nature, and we are assured that it is the intention of those interested in this scheme to make it a thorough success. Economical first cost and maintenance are the main objects sought to be achieved, and we shall keep our readers informed as to the progress of the work from time to time.

Legal Telephony.—Prof. S. P. Thompson could not decide in reply to a question asked during the discussion on "Telephonic Investigations" whether the human body was a diaphragm, but he was prepared to assert that it was a tube.

The Telephone in Devonshire.—A number of the leading tradesmen and inhabitants having promised to become subscribers, the Western Counties and South Wales Telephone Company has decided upon extending its operations to the rising town of Newton Abbot, which embraces a rather wide area, and requires, therefore, some improved mode of inter-communication. At 125, Queen Street, a temporary office has been opened, and the company has announced its intention of gratuitously conecting the police-station, the headquarters of the fire brigade, the hospital, and other public institutions, while another proposal is under consideration for establishing communication with the outlying parishes by means of instruments fixed at the clubs and reading-rooms. At Torquay business has materially improved, and it has been suggested that a telephone line between that town and Newton Abbot is "a consummation devoutly to be wished," considering that the telegraphic facilities at the present time are so poor that all messages passing between the two places have to be transmitted *via* Exeter.

Long Distance Telephony.—Experiments in long distance speaking have been made from the offices of the Northern District Telephone Company at Sunderland, the object being to refute the impression which some people have that it is not possible to speak to Liverpool or Manchester. The first experiment consisted in joining up various trunk wires, making a circuit 90 miles long, or 180 miles of wire. Speech was carried on over this length with perfect distinctness. The trunk wires between Middlesborough and Newcastle were then connected together and put through to Sunderland and Darlington, making a distance of about 220 miles, or 440 miles of wire. Though the result was not so good as in the former case, conversation was easily and distinctly carried on. There is little doubt that if wires had been available communication might have been held at a much greater distance. Arrangements are being made for carrying conversations over a distance of 325 miles.

The United Telephone Company.—Says the *Financial News*: "It is now nearly three months since a snowstorm threw the United Telephone system out of order, and it is out of order still. The subscribers to the system who paid in advance for the company's service are without any return for their money, and the company, secure in the possession of its subscribers' subscriptions, does not appear to be over-anxious to remedy the present state of affairs. Under these circumstances, it has been proposed—as all milder measures have failed to meet with success—that the telephone subscribers, whose money the United Telephone Company has taken without giving any adequate return for it, shall take combined action for the recovery of the amounts paid by them. We are quite in sympathy with this suggestion, and we shall be glad to receive the names and addresses of all telephone subscribers who are willing to co-operate in an effort either to secure the return of their money or to enforce the performance by the United Telephone Company of its contracts."

West African Cables.—As we notified on the 18th ult., the Sao Thomé-Loanda section of the West African Telegraph Company broke down suddenly off the mouth of the Congo on Friday afternoon, the 11th ult. The cable steamer *Buccaneer* was despatched from Silvertown on the 21st and arrived at Teneriffe on the 28th. She is expected to arrive at Sao Thomé on the 16th inst, when she will be joined by Mr. E. W. Parsoné, who will take charge of the repairs. Mr. E. March Webb, chief electrician, and Mr. A. S. Thomson, senior commander in the Silvertown Company's service, accompany the *Buccaneer*.

Massowah-Perim Cable.—The cable steamer *Seine*, belonging to the Telegraph Construction and Maintenance Company, sailed for Massowah on 28th ult. with cable to connect up this port with the Eastern Company's system in the Red Sea. The work is being carried out under contract with the Italian Government.

The Field Motor.—The entirely new departure taken by Mr. S. D. Field in the design for an electric street railway, says the *Electrical World*, must attract attention from the many interesting mechanical, as well as electrical, points it possesses. It will be noted that two conduits serve to carry the same number of conductors charged to an opposite potential with a generator at each end, so that each conductor is an independent source of power for the motor. In this way a defect in one conductor causes no interruption of traffic, as the other is still available. This constitutes a decided advantage, and makes the system entirely independent. As regards the mechanical construction, it will be noted that the tops of the conduits form the rail bearings and the wheels possess central flanges which run in the slots.

A Precautionary Suggestion.—"Housekeeper," Queen Victoria Street, writes: "It has occurred to me, through the recent burglaries in the City, that it would be well if the telegraph and telephone companies would supply their men with some sort of badge or certificate showing their *bona fides*, as under the present (as I think) very lax system, any fellow with a piece of wire or basket of tools gains access to the premises and roofs of many valuable properties on the plea of 'repairs to the pole.'"

Canadian Telegraphs. — Sir Alexander Campbell, the late Dominion Postmaster-General, has been appointed Lieutenant-Governor of Ontario.

The Dangers of Gas.—A fearful explosion took place about 2 o'clock on Monday at the Thurso Gas Works, whereby Mr. Young, the manager, was fearfully injured. Great destruction was caused to the property. Fortunately no one except the manager was in the department where the explosion took place.

Two serious gas explosions occurred in the metropolis on Wednesday, and resulted in much damage to property. An escape of gas from one of the gasometers belonging to the Economic Gas Company at Manor Works, High Street, Battersea, exploded, and considerable damage was done to the gasometer, and to the roofs of the lecture-hall and the conservatory of Southlands Wesleyan Training College close by. At 86, South Street, Walworth, an escape of gas was noticed, and upon the son of the occupant, Charles Norris, searching for it with a light, an explosion took place, which wrecked several of the rooms of the house. The young man was seriously burnt about the face and hands.

Melbourne Centennial Exhibition.—A circular of the executive commissioners invites the British, Foreign, and Colonial Governments to participate in this undertaking, and trusts that steps will be promptly taken by them for the completest possible representative display. Application for space is to be made before the end of August. The space will be free and motive power also. Goods will be received from May 1st, 1888, and the courts will be completed by July 15th, 1888. It is desired to make the exhibition specially interesting in manufacturing processes, machinery in motion, &c. There will also be a picture gallery lighted electrically.

Blenheim Telephone.—In the very extensive new infirmary for the sick poor of the St. Saviour's Union, which has been erected at East Dulwich, close to Champion Hill Station (and of which an illustration and description is given in last week's *Builder*), Blenheim telephones have been fitted in the medical superintendent's house, the centre of each floor of ward blocks, and at various other points in the building. An advertisement for tenders for the electric lighting of this institution appeared in January, 1886, but for some reason or other which does not appear, gas has been given the preference.

The Lane-Fox Patents.—A notice is issued by the Anglo-American Brush Electric Light Corporation stating that it is still prepared to indemnify any purchaser of its incandescent lamps against proceedings for alleged infringement of the patents of the Edison and Swan Electric Light Company; and that it has instituted proceedings against that company for infringement of the Lane-Fox patents.

Inventors' Rights.—An interesting decision has lately been given by the Supreme Court of the United States, in which the right of *employé* inventors were considered and adjudicated upon. The question in dispute was the ownership of letters patent for a plough, and the case of the plaintiffs, a company by whom the inventor (Hewitt) was employed, was that in devising and constructing the plough, Hewitt was only performing his duty as an *employé* of the company and carrying out his contract with it; that he was doing only what he was hired and paid to do; that the result of his labours belonged to the company, which became "in equity and good conscience" the true and rightful owner of the right to manufacture the plough. The decision of the Circuit Court, which was appealed against, was that Hewitt was not expressly required by his contract to exercise his inventive faculties for the benefit of his employers, and that whatever right to the invention the employers had by the terms of the contract was a naked licence to make and sell, which right, if it existed, was merely a personal one, and not transferable upon the dissolution of the company. Judge Blatchford, of the Supreme Court, held that the views taken by the Circuit Court were correct.

Light and Power.—The following facts respecting an important light and power installation, taken from the New York *Electrician and Electrical Engineer*, must make English electricians envious. Would that it would also make them emulous! "The Edison Electric Illuminating Company, Lawrence, Mass., runs a plant of a capacity of 5,400 10-C.P. lamps, including 1,000 municipal lamps. The power plant includes two 120 H.P., two 80 H.P., and one 35 H.P. engines. Sixty-five miles of wire are used in the street circuits. The underground system embraces over six miles of tubes, aggregating 18 miles of single conductor. Current is also supplied for 23 electric motors, ranging from one-half to 6 H.P., and running printing presses, elevators, lathes, &c., in various parts of the city. There are the following isolated lighting plants in Lawrence—Pemberton mills, 650 lamps; Arlington mills, 425 lamps; Russell paper mills, 200 lamps; Naumkeag mills, 550 lamps; Upton's Glue Works, 150 lamps."

Communication with Lightships and Lighthouses.—*Apropos* of the recent appointment of a committee for the purpose of inquiring into the desirability or otherwise of establishing electrical connection between lightships and outlying lighthouses and the shore, it is worth mentioning that nine or ten years ago this very same matter engaged the attention of the Plymouth Chamber of Commerce. The members of that body fully recognised the unnecessary danger occasioned by the isolation of lightships and lighthouses. It was then proposed to run a cable from the Rume Head to the Eddystone, but no tangible result was achieved, in spite of the terrible warning afforded by such a wreck as that of the *Heoyo* on the Eddystone. It is to be hoped that something more definite and more satisfactory will follow the appointment of the Board of Trade's committee.

The Police and the Telegraph.—It is stated that several important changes have, under the direction of Sir Charles Warren, the chief commissioner of the metropolitan police, been lately effected in the personnel and stations of the metropolitan police force, which tend to give the force something of a military character. A great improvement is a system of telegraphic intercommunication between the stations in various portions of the district which has just been completed. Direct communication is now established between such stations as Woolwich and Staines, or Croydon and Highgate. The police telegraphic system is also connected with the Post Office telegraphs, and so elaborate and complete are the arrangements, it is said, that a force of 7,000 policemen could be concentrated at any given spot of a central position within an hour.

Continental Telegrams.—Mr. Henniker Heaton asked the Postmaster-General whether he could state the amount of money paid to the Submarine Cable Company for conveying messages from England to France and from France to England last year; also the total amount paid to the company for Continental messages last year. Mr. Raikes: I do not think I am in a position to give a categorical answer to the hon. member's question, but it may interest him to know that the Post Office received during the year 1886 on account of Anglo-French messages the sum of £37,906, and that the total earnings of the Post Office under the joint purse arrangements with the Submarine Telegraph Company were for the same year £132,223.

Indian Telegrams.—Mr. Henniker Heaton asked the Under-Secretary of State for India on Saturday, whether he was aware that telegraphic messages from England to Australia were charged from Bombay to Madras 500 per cent. more than local messages over the same lines; and would he take steps to remedy the grievance.—Sir J. Gorst said telegraphic messages are charged from Bombay to Madras 75 centimes per word. Local messages are charged, if urgent, 45 centimes; if not urgent, 22½ centimes. The Government of India objects at present to incur the loss of revenue which a reduction of the rate on Australian messages would cause.

Petroleum as Fuel.—In reference to this subject, Mr. R. Miller, of 54, St. Enoch Square, Glasgow, writes:—"I noticed your inquiry in issue of 31st December as to my experience with oil as a fuel. The reason I did not reply is I have been an invalid confined to bed for fully three months, and am not able yet to do anything to business. In December, 1885, I started an installation with *creosote* oil as fuel, and it has been used ever since. This is a cheap oil that can be had here delivered for 1d. per gallon (that was the price when I was last at business, the colliers' strike may have altered it). It is got from the ammonia recovery process in gas producers at blast furnaces, and answers the purpose of fuel very well. My customers who have the installations say it comes as cheap as coal. My own observation, however, shows me it is a fraction dearer, but from the position and other matters in connection with the installation I fitted it to, it is worth much more than the difference; there is a complete absence of black coal smoke. We could not afford to burn petroleum at the price it is to be had in any of its forms here. I also noticed recently that the crude or refuse of the 'bakeo' oil, which Mr. Marvin said sold out there for 4d. a ton, was selling in Odessa at 18s. per ton; that does not look as if cheap oil fuel was in the near future."

Laxton's Builder's Price Book.—In the 70th edition of this annual publication, so indispensable to every architect, builder, surveyor, and contractor, which is just published, a section is devoted to electric lighting, giving the latest information and data on the subject from a builder's point of view. An endeavour is made to indicate the cost, roughly, of an installation, and to suggest the best quarters in which further information should be sought. As a guide in estimating the probable cost of introducing the electric light into houses on the central station system, particulars of the Kensington Court scheme are given. Estimates for independent installations of various kinds are also quoted, and reference is made to the system adopted by the Anglo-American Brush Corporation to meet the wishes of those who find it convenient to pay for the necessary plant in instalments extending over three years.

The British Association.—The British Association holds its annual gathering this year at Manchester, and a meeting has this week been held of the general local committee. A report of considerable length was presented, which stated that the guarantee fund now amounts to about £9,000, but a larger sum is needed. Complete arrangements have been made respecting the meetings of the different sections of the association, the municipal authorities and the officials of Owens College having placed a large number of rooms at the disposal of the committee. The presidential address will be delivered in the Free Trade Hall, which is capable of accommodating between 5,000 and 6,000 persons. The Royal Jubilee exhibition, the art gallery, and other institutions will be thrown open to members of the association. A provisional list of excursions has also been drawn up. A list of 500 names of distinguished foreigners has been prepared, and to each of them a circular of invitation is about to be issued.

Underground Wires in New York.—Such is the tangle and trouble in the work of putting the wires of this city underground, says the New York *Electrical World*, that only new legislation can bring matters into good shape and enable the Commission to carry out its plans. In fact, all sorts of proposals are now before the Legislature, but the Bill we print is that which the Commission favours, as putting it in the position it desires to occupy. Meantime, the companies that wish to take part in underground operations but have not so far enjoyed any patronage from the Commission, are seeking to make the most of the opportunity thus presented, and will now do their best to be ensured a share of the work. Altogether it is a "state of things" that will serve as a lesson to other communities modelling after New York.

The Electric Battery Brush Company.—Says the *Financial Critic*, respecting this company:—"We do not think the Electric Battery Brush Company, Limited, are likely to obtain subscriptions for many shares. Although, no doubt, the patentee, Miss MacMullins, is a very clever person, we must not forget that several other similar companies that have been formed, have not turned out successfully. The fact, too, that Messrs. De la Torre and Hannon are promoting the concern is not anything in its favour. Probably this is the reason why the prospectus provides that subscribers are to waive their right to a detailed statement, both as to the names of the parties to the agreement, and the amounts payable thereunder."

Underground Electric Railroad.—At Philadelphia, Pa., the *Engineer* states, an underground railroad, to be operated by electricity, is projected. The speed will be twenty miles per hour between stations; the stations will be placed every third of a mile in the suburbs, and every quarter of a mile in the city. The cars will seat thirty-eight persons each, and will have side doors. In New York City a legal decision has been given which practically frees the Arcade Railroad Company from further interference, and it is reported that work will be commenced on the tunnel before very long. There are four corporations holding franchises for underground railroads in this city, all of which are controlled by the United States Subway Company. This company declares its intention of commencing work as soon as a permit is granted by the Public Works Department. The charter to be operated under only allows for a double track road; other charters were for four tracks, two for express and two for way trams. There will be two tunnels occupying a space of 15 feet high, by 35 feet wide. Though well supplied with street railroads (tramways) and elevated railroads, the city can supply abundant traffic to an underground line.

The "Times" on the Phonopore.—A screamingly funny article on the inductional apparatus of Mr. Langdon Davies, which he is pleased to call a "Phonopore," appeared a few days since in the *Times*. We extract a few choice items: "The phonopore gives uninterrupted passage to electrical effects capable of being associated with sound, although it does not permit the passage of electric currents." . . . . "It was while investigating the phenomena of induction with the view of finding means to obviate its effects in telephones that Mr. Langdon-Davies was led to his important discovery. He came to the conclusion that the effects ascribed to induction afforded evidence of the existence of a form of electrical force which might be separated from currents and which could pass freely through insulators impassable by currents." . . . . "But the phonopore does much more than the ordinary duplexing systems can do, for it both duplexes and diplexes the wire—that is to say, it enables the wire to carry its two messages either in the same or in opposite directions. More than this, if the line be already working either duplex or diplex on the ordinary system, the phonopore telegraph service can still be added to it as if the wire were being used for nothing else." . . . . We further understand from our ponderous contemporary that the duplexing of a telegraph service by adding a simplex phonopore, possesses many advantages over the ordinary duplex system now in use, as pointed out by Mr. Clark. Not the least important of these is that of cost, which in construction is put at probably less than half the cost of the duplex, while the cost of working is also stated to be less. With all these advantages, is it not a little strange that the phonopore is not at once snapped up by our Postal Telegraph authorities? By its aid surely the balance-sheet of the Telegraph Department might be made to show a profit instead of a deficiency for each year's working.

South African Telegraphs.—The telegraph revenue of the Cape Colony for 1886 was £3,936 less than in 1885.

The Mance Grapnel.—Sir Henry Mance, *Engineering* states, has devised a grapnel for lifting submarine cables, which has, in addition to the ordinary pair of prongs, a pair of curved bars which spring from the neck of the grapnel and bend over towards the toes of the prongs but do not meet these. They serve as fenders or protectors of the prongs on rocky ground, while allowing the cable to be caught on the prongs in the usual way.

Electric Lighting Charges in America.—The New York *Electrician and Electrical Engineer* gives the following list of prices with which the Boston Electric Light Company—formerly the Brush and Merchants' Companies—began the new year :—

ARC LIGHTS.

1 Arc lamp, contract for	12 months	.....	75 cents per day.		
1 „ „	6 „	.....	80 „	„	
1 „ „	3 „	.....	90 „	„	
2 Arc lamps „	12 „	...each	70 „	„	
2 „ „	6 „	... „	75 „	„	
2 „ „	3 „	... „	85 „	„	
3 or 4 „ „	12 „	... „	65 „	„	
3 or 4 „ „	6 „	... „	70 „	„	
3 or 4 „ „	3 „	... „	80 „	„	
5 to 9 „ „	12 „	... „	60 „	„	
5 to 9 „ „	6 „	... „	65 „	„	
5 to 9 „ „	3 „	... „	75 „	„	
10 „ „	12 „	... „	50 „	„	
10 „ „	6 „	... „	55 „	„	
10 „ „	3 „	... „	65 „	„	

INCANDESCENT LIGHTING.

For 125 C.P. lamps, in series of three.

Contract for	12 months	..... each	50 cents per day.
„	6 „	..... „	55 „ „
„	3 „	..... „	60 „ „

For 60 C.P. lamps, in series of three.

Contract for	12 months	..... each	30 cents per day.
„	6 „	..... „	35 „ „
„	3 „	..... „	40 „ „

For 16 C.P. lamps, in series of eight or its multiple, special rates will be made.

The Motor Challenge.—Probably by this time Mr Sprague regrets that he indulged in such "tall talk" as was contained in the letter which we published last week. Professor S. P. Thompson and Mr. Mordey have both replied in a manner which we fear will not afford him much consolation. Whether Professors Ayrton and Perry consider the matter worthy of notice remains to be seen.

Referring to the above subject, *Industries* says :—"On the first glance, it seems difficult to realise what may have been the object of Mr. Sprague (apart from that of advertising his company) in formulating the above conditions, which evidently exclude the most recent and best designs ; but on further consideration it is evident that Mr. Sprague wishes to show that he could, five years ago, obtain results which were beyond the reach of his English rivals. In other words, he wishes to show that he possessed at that date original knowledge not shared by others. Now, it seems that it is much easier to prove such points by reference to the records of the patent offices, especially since Mr. Sprague has made free use of the protection so readily afforded by the Washington office to American inventors, than by the clumsy device of actually building machines on obsolete designs, the early date of which must be certified by three witnesses, and we would recommend this simple and inexpensive method in preference to Mr. Sprague's proposal, which would not in the slightest degree assist anyone in the construction or application of electro-motors."

City and Guilds of London Institute.—Mr. Herbert Clifford Saunders, Q.C., has been elected chairman of the executive committee and a vice-president of the Institute, in place of Sir Frederick Bramwell, F.R.S., resigned. Sir Frederick Bramwell was elected chairman of the executive committee at its first meeting in November, 1878.

Fireproof Wood.—The General Electric Apparatus Company, of Great St. Thomas Apostle, London, is employing, in the manufacture of its switches and for other purposes, wood which has been submitted to a process rendering it perfectly fireproof. The company, we understand, does not itself undertake installation work, but aims at being able to supply from stock every requisite of the electrical engineer, and in its new showrooms, which are close to Mansion House Station, will be found a very large variety of general supplies.

Wood Pulleys.—An effort is being made to introduce into this country the Independence patent wood pulleys manufactured by Messrs. Dodge Brothers, of America. They contend that the driving power of wooden pulleys is, as a rule, greater than those with iron rim, and they guarantee in the case of their own poplar face pulley that it will in every case transmit from 25 to 60 per cent. more power with the same belt than any iron pulley made with like tension of belt. The Franklin Institute in January, 1885, awarded the makers a certificate of merit, and the committee appointed to examine the Dodge patent wood split pulley and patent bushings, reported that they found "that the compression fastening of wood on iron, with wooden bushings, will hold it firmly upon the shaft and is, in a majority of cases, better than an iron pulley, from the fact that it can be made lighter, and thus save weight on the line shaft and bearings, thereby reducing friction. It is a well-known fact that a wooden pulley is better than an iron pulley, from the fact that it holds a belt much better. From the best authority, this latter amounts to at least thirty-three (33) per cent. The manner of fastening the pulley to the shaft does not mar nor injure the shafting in the slightest degree, and therefore does not tend to throw the pulley out of balance, as is the tendency with pulleys secured by keys and set-screws. The pulley is built of wooden segments, the face being made of poplar. The two halves of the pulleys are secured to the shaft with eight bolts. The bushings to fit different sized shafts are made of hard wood, thoroughly air-dried, then bored and kiln-dried ; then each bush is counter-bored to exact size of shaft, then carefully turned on the outside to fit the bore of the pulley. They are then cut transversely in halves." The agents in London very fairly offer to supply a pulley on trial, and to take it back at the end of 30 days if it does not give satisfaction.

The Edinburgh Exhibition Awards.—A paragraph appeared in our last issue to the effect that the Edison-Swan Company had been awarded the only gold medal for electric lighting at the Edinburgh Exhibition. As announced in our issue of November 5th last, the only gold medal at that exhibition was awarded to the Thomson-Houston system. The fact that Messrs. Laing, Wharton and Down are agents for both systems seems to have originated the error in some unexplainable way.

Technical Education.—Mr. L. Fry asked the Vice-President of the Committee of Council on Education, a few days ago, whether the Education Department had taken any steps in pursuance of the recommendations of the Royal Commission on Technical Instruction with respect to grants in aid of science schools and art schools. Sir W. Hart-Dyke replied that the Science and Art Department brought the matter before the Treasury in May last and again in November, urging (1) the abolition of the restrictions by which building grants can only be made to science schools built either under the Public Libraries' Act or in connection with a school of art, and (2) the increase of the limit to which both science and art building grants may be made up to a *maximum* of £800 ; but the Treasury were not convinced of the necessity for the proposed changes. The question formed part of the larger one as to the amount and method of the general encouragement that could be given to technical instruction, which was engaging the careful attention of the department.

The Cowles Smelting Process.—We understand that the dynamo being made for the above by Messrs. Messrs. R. E. Crompton & Co., to which we referred a fortnight ago, is designed for a current of 5,000 ampères. It will have an armature of the drum type, the conductors consisting of copper bars wound, or rather laid on in four distinct circuits.

Magnets of Dynamos.—We note that nearly all the dynamo makers are adopting the single magnet type of machine, in which for each pair of armature poles there is only one horseshoe. In the older forms there are for each pair of armature poles two horseshoes wound to form consequent poles at their junction. The former contains more iron but less copper for the production of a similar field. Both forms have their respective advantages, and although the first is being adopted, for some reasons the second is in no way out of date.

The Electric Arc.—It is a curious fact that if the current in an arc circuit is kept constant, the proportion in which the two carbons are consumed is affected by the electromotive force at the lamp terminals as well as the total quantity consumed.

Hall's Phenomenon.—In the last issue of *Repertorium der Physik* is published a most elaborate paper of no less than 22 pages, on "Hall's Phenomenon," by A. v. Ettingshausen and W. Uernst.

Unipolar Induction.—Prof. Franz Exner and Dr. Paul Czermak have a paper in the last number of *Repertorium der Physik* on "Unipolar Induction."

The Result of Dishonesty.—At the Southwark Police Court on Tuesday, the 22nd ult., before Mr. Slade, William Lawrence, about 50 years of age, who gave no address, was charged on remand with stealing, on the 15th ult., from the roof of 43, Union Street, Borough, a quantity of copper wire valued at seven shillings, the property of the United Telephone Company. The prisoner, who had completed a term of four years' imprisonment in 1865, elected to be dealt with at once in preference to being committed to the Assizes, and he was sentenced to three months' imprisonment with hard labour.

Electro-Technical Literature.—Messrs. Whittaker and Co. will publish shortly a second and much enlarged edition of "Magneto and Dynamo-Electric Machines," this being the first volume of their "Specialists'" Series. In the new edition some alterations in the text have been made, and Mr. W. B. Esson has written a preface and chapter on the latest types of generators. The work contains thirty-seven more illustrations, and gives full particulars of the most modern machines.

Electric Launch.—We hear that the electric launch which Mr. Elieson has in hand is to be fitted with his patent gearing as employed on the tramcars.

The Magnetic Circuit.—Messrs. Paterson and Cooper are constructing some dynamos in which the single horse-shoe magnet employed is a solid forging, without any joints. The horse-shoe is formed by slotting the centre part of a solid slab.

The "Management of Accumulators."—The second edition of Sir David Salomon's little handbook on the "Management of Accumulators" will shortly be published by Messrs. Whittaker & Co.

Navigating the Suez Canal.—*The Revue-Gazette Maritime et Commerciale* for February 25th last, contains an interesting article, compiled from the *Bulletin Décadaire* of the Canal Company, on the "Electric plant necessary for navigating the Suez Canal at night." It is illustrated with plans of both fixed and portable installations.

The Kensington Court Installation.—The cost of laying on cables from the main to the houses varied from £1 to £1 10s. per yard; the cost of supplying the wires to the different parts of a house from £7 to £10 per house. The cost of fitting up the lamps, &c., may be reckoned at about £1 15s. per lamp in undecorated houses, and an extra 5s. per light for the repairs to decorations. The charge made by the Kensington Court Company is by meter at the rate of 8d. per 1,000 watts, and the following particulars taken from "Laxton's Price Book" may be of interest:—

	Per hour.	Per quarter, sunset till 8 p.m. 606 hours per annum.	Per quarter, sunset till 9 p.m. 924 hours per annum.	Per quarter, sunset till 12.30 a.m. 2,372 hours per annum.
		£ s. d.	£ s. d.	£ s. d.
For each 10 C.P. lamp ...	¼d.	0 3 2	0 4 9	0 12 0
For each 20 C.P. lamp ...	½d.	0 6 0	0 9 0	1 4 0
For each 500 C.P. arc lamp	5d.	3 5 0	4 5 0	12 0 0

Rent of meter: 60 lights, 6s.; 120 lights, 10s. per quarter.

The Lay Torpedo.—We understand that the directors of the Lay Torpedo Company will give demonstrations with their apparatus to-morrow in the estuary of the Colne. The War Office will be represented by the Inspector-General of Fortifications, Captain G. S. Clarke, R.E., Aide-de-Camp, Captain Drury, R.N., and Lieut.-Col. Armstrong, R.E., Inspector of Submarine Defences.

The Broomhill Installation.—We shall be glad to know whether there is any truth in the report that a number of leads at Broomhill have become impaired, owing, it is understood, to some peculiar method of tinning the copper conductor.

The Society of Telegraph-Engineers and Electricians.—At the meeting to be held on Thursday, March 10th, Mr. Desmond G. FitzGerald (member) will read a paper on "Reversible Lead Batteries and their use for Electric Batteries."

Distinction for an Electrician.—We are informed that His Majesty the King of Portugal has, on the recommendation of His Ministry, appointed Mr. E. W. Parsoné, a Knight Commander of the order of Christ, in recognition of his services in connection with the establishment of telegraph communication between Portugal and her West African possessions.

Electricity in the Navy.—The turret ship *Ajax* has arrived at Chatham for the purpose of refitting before joining the Reserve Squadron. Her electrical apparatus is to be removed, and new machinery substituted.

Underground Conductors.—Owing to a mistake in numbering the MSS. pages of Mr. Callender's letter last week the figures given therein came in the wrong place; in other words the last should be first.

M. Marcel Deprez's Inventions.—The *Times* correspondent at Paris telegraphs:—"M. Edouard Drumont, the French Jew-baiter, who accused M. Marcel Deprez, the eminent electrician, of plagiarising the inventions of others, has been condemned to pay 6,000 francs fine and damages. The libellous pages in the unsold copies of the book are also to be torn out."

London-American Exhibition.—The electric lighting of this exhibition, which is to be opened in May next, has been entrusted to Messrs. Laing, Wharton and Down, the agents in this country for the Thomson-Houston system. About 250 arc lamps of 2,000 C.P. will be required. In connection with the out-door sports, which are to form a novel feature of the entertainments, some Brush search lights are to be operated by the Anglo-American Brush Electric Light Company, but with that exception the whole lighting of both building and gardens will be on the Thomson-Houston system.

The Alleged Death of M. Mercadier.—We are glad to learn that the announcement of the death of M. Mercadier, Directeur des Etudes de l'Ecole Polytechnique, Paris, is incorrect. Mr. J. Aylmer writes to us that the statement in our colums (taken by us from *Nature*) has caused M. Mercadier, who is in his usual good health, to be inundated with calls, letters, and enquires, and he has, therefore, suffered some annoyance. We very much regret that this should have been the case, and have much pleasure in making the correction. We are curious, however, to learn how such a mis-statement originated.

NEW COMPANIES REGISTERED.

Ottoman Electric Works Company, Limited.—Capital: £50,000 in £20 shares. Objects: To establish electric works in Constantinople and other parts of Turkey and Egypt, and to secure the sole and exclusive right to manufacture and supply the Shippey incandescent lamps throughout the Ottoman Empire, including a secret process for the manufacture of carbons and metallic filaments for electric lighting and other purposes. To manufacture gas, petroleum, and other engines: dynamos, machinery, cables, wires, batteries, motors, thermopiles, plant, arc and other lamps, candles, instruments, fittings, and apparatus for producing, storing, supplying or using electricity for light, heat, motive power, and means of communication. Signatories (with one share each): J. F. Lovering, 77, Gresham Street; E. Easton, C.E., 11, Delahay Street, S.W.; A. Beckwith, 10, Noble Street; John Todd (engineer), 14, Wentworth Road, Manor Park, Essex; H. Woodward (electrician), 20, Macfarland Road, Shepherd's Bush; Radcliffe Ward (electrical engineer), 10A, Great Queen Street, Westminster; Major-General W. Ryrie Alexander, Dartmouth, Devon. The signatories are to appoint the first directors, and the company in general meeting will determine their remuneration. Subsequent directors will be required to hold shares or stocks of the nominal value of £200. Registered 24th ult. by Walter Webb & Co., 23, Queen Victoria Street.

"Rose" Primary Battery Company, Limited.—Capital: £50,000 in £1 shares. Objects: To acquire letters patent for batteries or for other purposes in connection with electric lighting or motive power, and for such purposes to adopt an agreement of 22nd ult. between George Fitzhardinge Rose and Henry Potter. Signatories (with 1 share each): E. Oldenbourg, Mill Hill Park, N.; H. W. Spratt, Lee Road, Blackheath; J. Sinclair (engineer), Woodville, Putney; J. A. Mason, 94, Grosvenor Road; C. Clark, 20, Great St. Helens; H. B. Bunkell, 46, Queen Victoria Street; J. H. P. Partington, Paris. The signatories are to appoint the first directors. Remuneration: £300 per annum. Qualification for subsequent directors: 20 shares. Registered 26th ult. by W. Hope, 46, Queen Victoria Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Pacific Telegraph Company, Limited.—The statutory return of this company, made up to the 15th ult. was filed on the 25th ult. The nominal capital is £2,000,000 in £10 shares. 18 shares have been taken up and the full amount has been called thereon, the calls paid amounting to £120, and unpaid to £60. Registered office. 34, Clement's Lane, E.C.

Electrified Rooms Company, Limited (Captain Arthur H. Byng Patents.)—The registered office of this company is at 24, Landport Terrace, Southsea.

Winfields, Limited.—The registered office of this company is at 47, Holborn Viaduct, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

Telegraph Construction and Maintenance Company, Limited.

The twenty-third ordinary general meeting of this company took place at the offices, 38, Old Broad Street, on Tuesday, under the presidency of Sir Daniel Gooch, Bart.

Mr. Shuter, manager, having read the notice convening the meeting,

The Chairman moved that the report and accounts be adopted, and that a dividend of 36s. per share, in addition to 12s. per share, interim dividend, paid on June 30th, 1886, be paid on all shares of the company for the year ending December 31st, 1886, and that such dividend be paid free of income-tax. He said the shareholders would see by the accounts that the net profits for the year had been £75,651, not charging the interest on their debentures. To this sum must be added £65,267 brought forward from last year, making a total of £140,918. From this amount was deducted the interim dividend of 5 per cent. paid in July, 1886, amounting to £22,410, leaving £118,508 to be dealt with. Of this sum the directors proposed to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent. free of income tax, leaving £51,278 to be carried forward to the next account. These figures did not show quite so good a result as had been anticipated. Although not an unsatisfactory one, it had been necessary to take about £14,000 from the large balance brought forward from the previous year in order to enable them to pay 20 per cent. During the year they had laid 2,476 knots of cable, and had just started a ship to lay 260 miles of cable in the Red Sea. The work in hand was very little. In addition to the cable laid they had manufactured 832 miles which had been stored for repairing purposes. It might be interesting to know that they had laid 96,000 miles of cable during the time they had been a company. With regard to electric lighting, they were unfortunately still litigating, and therefore he had better say nothing about it. What would be the result of that litigation he did not know; it had been going on for a considerable time, and it would come before the judge again on Friday week. As to the quality and efficiency of the light there was no question, and the only difficulty was as to whether they could produce it by the machinery they had erected without creating a nuisance to the neigbourhood.

Sir George Elliot, Bart., M.P., seconded the adoption of the report and accounts.

Mr. Croft asked whether any other experiments were to be made. Was the Paddington contract the only one the company had?

The Chairman said it was the only contract, and he thought that, until they were quite satisfied about that, they should hold their hands.

Mr. Croft did not think that litigation with regard to the Paddington lighting should deter the directors from accepting other contracts for electric lighting.

The Chairman said he did not think that would deter them, if they really had the offer of a contract to which they could clearly see their way. They had a concession for lighting St. James's, but the Act of Parliament which tied the hands of electric companies prevented them from acting upon it. He hoped, however, that that Act would soon be set aside. In the meantime they did not think it wise to embark upon the lighting af St. James's, because it would involve a very large cost, and they hardly knew what position they would be in under the Act until they made the experiment. The day would come when electric lighting would be the real lighting of the country; of that there was no doubt. But at present he thought they were prudent in holding their hands.

Mr. Abbott having commended the prudent course which the directors had taken, the resolution was put and carried.

Sir Daniel Gooch and Sir Thomas Fairbairn, the retiring directors, and the auditors, Mr. John Gane and Mr. James Glegg, were all re-elected, and the proceedings were brought to a close with a vote of thanks to the chairman.

Telephone Company of Egypt, Limited.

THE ordinary general meeting of this company was held at the offices, Austinfriars, on Tuesday.

Lieutenant-General A. Fraser, C.B., R.E. (Chairman), stated that the business of the company had increased very considerably. The number of subscribers in Egypt had increased from 454 in 1883 to 817 in 1886. The gross revenue, which in 1883 amounted to £6,400, had increased in 1886 to £9,400. They could, he thought, hardly expect to increase the business in Egypt to so large an extent in the future, but a satisfactory business was still in progress, and was likely to further develop. They proposed to pay a dividend of 6 per cent. on the preferred shares, and it was proposed to pay off the arrears of 4½ per cent. on the cumulative dividend of 1884 and 1½ per cent. on account of the year ending December, 1885.

The report was adopted, and the payment of the dividend in the way proposed agreed to.

The Maxim-Weston Electric Company, Limited.

The directors, in submitting their annual balance sheet and profit and loss account for the year 1886, remark that a large

number of orders since received were not in time to be included in the accounts for the past year. The operations during the past year have resulted in a profit of £3,366 12s. 2d. after deducting all expenses. The total balance available at the credit of profit and loss account, including the amount brought forward from last year, is £3,964 1s. 10½d. The directors recommend the payment of a dividend of 5 per cent., which will leave the sum of £164 1s. 10½d. to be carried forward to next year.

There having been issued to shareholders during the year 50,000 shares at par value, which were then selling at a large premium, the total sum distributed during the year is equivalent to fully 10 per cent. on the capital of the company issued to date.

The directors are pleased to state that they have secured on lease, within three miles of the Bank of England, a newly-built, spacious, and most suitable factory, at a comparatively low rental, which is probably the largest and finest electrical factory in Europe, and of such superficial area as will admit of any necessary extension.

The plant and machinery at factory have been most carefully valued, and a due allowance made for depreciation. These items considerably exceed last year owing to necessary extensions made to meet the growing requirements of the company, and the probable large increase of business which will follow the removal of the existing restrictive legislative enactments.

The company has now a complete experimental staff which, with the specifications of new patents constantly being received from the American Company, will enable the company, as heretofore, to supply plant combining all recent improvements.

The directors report that all installations fitted up by the company to date have given satisfaction, and that every effort is being made to secure a good share of electrical orders in the various manufacturing districts of the country as well as on the Continent, and throughout the East Indies and other Colonies. The outlook for the business of the current year satisfies them that they can safely assure the shareholders of gradually increasing prosperity, and that the orders now in hand are in excess of those for any past year.

The Western and Brazilian Telegraph Company, Limited.

THE Directors state in their report that they have already explained by circular their reasons for the change of the company's year, and, in accordance with such circular, now submit their report and the accounts of the company for the fifteen months ended December 31st, 1886.

The earnings for the twelve months to September 30th amount to £125,253 7s. 11d., a decrease of £2,143 1s. 6d. compared with last year, arising partly from the general dulness of trade and partly from lower tariffs, which came into operation in May, consequent upon further competition. The directors are, however, pleased to be able to report a marked improvement in the traffic for the quarter ending December 31st, 1886, which shows an increase of no less than £14,262 as against the same quarter of 1885. The total earnings for the fifteen months amount to £169,882 0s. 11d.

The ordinary working expenses for the twelve months (exclusive of renewals of cable and repairs to the *Norseman*) amount to £53,743 10s. 11d., as against £60,155 19s. 4d., a decrease of £6,412 8s. 5d. But to form a more correct comparison the sum of £1,800 for depreciation of *Norseman* should be added to the expenses of the twelve months. These would then stand as £55,543 10s. 11d. as against £60,155 19s. 4d., a decrease of £4,612 8s. 5d. The ordinary working expenses for the quarter to December 31st amount to £15,088 6s. 9d., and for the fifteen months £68,831 17s. 8d. The expenses for the quarter ended December 31st, 1886, must not be taken as a criterion of the annual outlay, inasmuch as during this particular quarter, items of expenditure occur which run over the whole year.

During last year the ss. *Norseman* was thoroughly repaired at a cost of £6,397 19s. 0d., and the entire amount has been charged to the revenue of the fifteen months. The repairs and alterations placed the vessel in good order and condition and added to her value, consequently the directors determined not to write off the usual amount for depreciation.

The greater portion of the 200 miles of cable (viz., 162 miles) referred to in the last report has been inserted into the system with most satisfactory results, the interruptions during the year having been much fewer than before. The amount thus expended, £15,432 12s. 7d., has been charged to the renewal fund.

Including the amount brought forward from 1885, the balance to the credit of the revenue account for the fifteen months is £62,499 19s. 5d., of which £12,500 has been placed to the renewal fund, leaving £49,999 19s. 5d., from which the directors recommend the payment of a dividend of 13s. per share, or at the rate of £3 9s. 4d. per cent. per annum for the fifteen months free of income-tax, leaving £4,558 9s. 5d. to be carried forward. This will give to the preferred ordinary shares £5 per cent. for the fifteen months or 9s. 4½d. per share, and 3s. 7½d. per share on account of arrears for the year ended September 30th, 1884. This payment with the additional 9d. per share paid last year to the preferred ordinary shares, reduces to 3s. 1½d. per share the amount in arrear upon these shares to December 31st, 1886.

The Directors, availing themselves of the opportunity of sending stock cable to Brazil, purchased by tender, 100 miles of "main" cable, and 10 miles of "shore end" for general repairs; with this cable the *Norseman* returned to Brazil in August last.

Brazilian Submarine Telegraph Company, Limited.

—The directors of this company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax for the quarter ended 31st December last, and payable on the 25th inst. The books of the company will be closed from the 18th to the 24th inst., both days inclusive.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of February was 3,821, estimated to produce £3,000, against 3,402 messages, producing £2,771 in the corresponding month of last year. The receipts for the month of November, estimated at £2,550, realised £2,580.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 25th were £2,622 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for February amounted to £35,553, against £33,688 for the corresponding period of 1886, or an increase of £1,865.

The Direct Spanish Telegraph Company, Limited and reduced. The estimated receipts for the month of February were £1,616, against £1,588 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for February amounted to £46,900, against £48,814 for the corresponding period of 1886.

NEW PATENTS—1887.

2851. "Automatic switch and cut-out for electrical circuits." T. PARKER. Dated February 24.

2906. "Commutating switches for electric circuits." E. W. BECKINGSALE. Dated February 24.

2959. "Combined bell, push, and automatic switch for electric alarms." H. C. CHOCQUELL. Dated February 25.

2961. "Telegraphic and other writing machines." H. J. HADDAN. (Communicated by B. F. Christiansen.) Dated February 28. (*Complete.*)

3056. "An alternating current sparkless commutator for an electric dynamo." H. AYLESBURY, J. MILNE. Dated February 28.

3057. "Brushless and sparkless commutator for an electric dynamo." H. AYLESBURY, J. MILNE. Dated February 28.

3087. "Dynamo-electrical machines." E. WILSON. Dated February 28.

3098. "Electric candles." B. J. B. MILLS. (Communicated by A. Million.) Dated February 28.

3102 "Diaphragm for mechanical or acoustic telephones." J. COTTON. Dated February 28.

3125. "Electrically transmitting and receiving articulate speech, &c." W. D. HOUSE. Dated March 1. (*Complete.*)

3140. "Producing induced currents." J. C. PUETHNER. Dated March 1.

3158. "Machines for giving currents of electricity on the insertion of a coin, &c." P. EVERITT. Dated March 1.

3174. "Rheostats, or apparatus for continuously varying electrical resistance within limits." P. CARDEW. Dated March 1.

3197. "Separating plates in secondary batteries." Sir D. L. SALOMONS, T. PARKER, P. B. ELWELL. Dated March 2.

3225. "Generating and distributing of electric energy; machines or appliances therefor." R. DICK, R. KENNEDY. Dated March 2.

3233. "Automatic carbon feed for electric arc lights." H. J. HADDAN. (Communicated by L. Levavasseur.) Dated March 2

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

12015. "Dynamo electrolytic battery." R. EISENMANN. Dated October 9. 8d. Claims:—1. A. The immediate and stationary metallic connection of the coils of a Gramme ring with electrodes, that the current generated in the ring can enter direct into the electrodes without being conducted over springs, and that together with the turn of the ring a change of the electrodes takes place. B. The interposition of resistances in this connection to collect the current in the ring and to effect that it may flow only through those wires which are 90° from the fixed magnets. 2. The position of a rotary battery between the poles of magnets or electro-magnets, so that a current is induced in the liquid by its rotation. 3. A. The position of a rotary battery between a fixed battery in the same tank and their metallic connection, so that the current enters between the ring and the resistances. B. The application of the interposed resistances to the rotation of the axis on which they are fixed by means of placing them between the poles of magnets or electro-magnets.

12372. "Improved means for regulating the action of dynamo-electric machines." L. J. CROSSLEY, W. T. GOOLDEN, and A. P. TROTTER. Dated October 16. 8d. Claims:—1. The use of a centrifugal governor applied to shunt-wound dynamo-electric machines, and fitted as described for increasing or decreasing the resistance in the shunt circuit of such machines, as and for

the purpose set forth. 2. The arrangement described for compensating for the reversing of the direction of rotation of the dynamo-electric machine. 3. The arrangement described for automatically cutting out the dynamo-electric machine from the main circuit, and re-connecting it therewith.

16038. "An improved method of, and apparatus for, distributing electric currents." (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated December 30. 8d. Claims:—1. The described method of distributing electric currents by dividing the district to be supplied into sub districts provided with separate inductors radially connected to the source of electricity, and connected with each other by equalising conductors, with means of farther regulating tension by including or excluding suitable resistances, substantially as herein described. 2. In combination with a number of inductors arranged in parallel connection with a source of electricity, equalising conductors connecting opposite poles of their primary coils, substantially as and for the purpose herein set forth.

1886.

283. "An improved electro-mechanical governor." O. E. WOODHOUSE and F. L. RAWSON. Dated January 7. 8d. Claims:—1. The combination of any known mechanical governor with an electrical controlling device to perfectly adjust the speed of the prime motor by small variations in the current of an electrical circuit, so as to maintain the electromotive force or strength of the latter practically constant. 2. The combination of an electro-mechanical device, set in operation by variations in the electromotive force or strength of the electrical current in the working circuit, with any known mechanical governor, such as a centrifugal governor, the electrical device being arranged to alter the pressure of a spring or weight on the said governor, substantially as described. 3. The combination of an electro-mechanical device, set in operation by variations in the electromotive force or strength of the electrical current in the working circuit, with any known mechanical governor, such as a centrifugal governor, the electrical device being arranged to alter the length of the connecting rod or its equivalent between the governor sleeve and the admission valve gear operated thereby, substantially as described. 4. An electrical device in the form of a solenoid, with or without a relay, actuated by variations in the electromotive force or strength of the working current, and operating a clutch so as to alternately engage in a pair of bevel or mitre wheels, or equivalent friction discs, gearing into a nut and screw, controlling the spring or attachments of any known mechanical governor, such as a centrifugal governor, in combination with the mechanical or centrifugal governor so controlled, substantially as described.

1054. "An improved construction or formation of plates with composition for electric batteries." J. H. NOAD and R. MATTHEWS. Dated January 23. 4d. Claim:—Compounding oxide of lead or litharge and glycerine as a coating for electric battery plates, as described.

1150. "Improvements in and relating to electro-dynamic motors." T. J. HANDFORD. (Communicated from abroad by F. J. Sprague, of New York.) Dated January 26. 8d. Claims:—1. An electro-dynamic motor having shunt field coils and series field coils arranged to form polar lines at right angles to each other, and the said series coils being part differential and part cumulative with relation to the shunt coils, in combination with means for reversing the magnetising effect either of the said cumulative or the said differential coils, or of both the said sets of coils, substantially as described. 2. An electro-dynamic motor having series and shunt field coils wound so that the series coils distort the poles set up by the shunt coils, in combination with means for reversing the direction of distortion, substantially as described.

1220. "Improvements in electric clocks." J. CASSEY and J. F. DIXON. Dated January 27. 6d. Claims:—1. The combination of paraffin oil, turpentine, spirits of wine, or other similar non-conducting liquids, applied on the aforesaid principles with the metals for electrical contact as aforesaid, and with the electric current flowing from part of contact rheotome or break which is rubbed on the smalled impact contact surface to the surface on which is the long or greatest run or rub on intact contact surface, as and for the purpose herein specified. 2. The combination of non-conducting liquid, as hereinbefore mentioned, with the metals for electrical contact and with the electric current flowing from the electric contact rubbing surface, which is rubbed on the smallest impact contact surface to the impact electric compact rubbing surface on which is the long or greatest run or rub, as and for the purpose herein specified.

1337. "Improvement in electrical switches." F. L. RAWSON and J. H. DAVIES. Dated January 29. 8d. Claims:—1. The combination in an electrical switch of contact studs, passed over by a rotating or moving switch arm, connected alternately to the desired circuits; with intermediate contact studs, connected through a suitable resistance to the next succeeding stud in that direction in which the switch arm is to move, to bring into the circuit an increased number of cells. 2. The construction of such an electrical "non-arcing" switch, substantially as described. 3. The combination of such an electrical "non-arcing" switch with switches and instruments upon a single switchboard, for controlling and measuring electrical currents, substantially as described.

1496. "Improvements in or relating to electric bells." T. P. C. CRAMPTON. Dated February 2. 8d. Relates to that construction of bell wherein the armature, electro-magnets and clapper are contained within the bell proper. There is one claim.

1591. "Improvements in telephonic switching apparatus." A. R. BENNETT. Dated February 3. 8d. Claims:—1. As a development of the invention described under letters patent No. 16964, of 1884, the employment in telephonic switch apparatus of induction coils for the purpose set forth. 2. As a development of the invention described under letters patent No. 16964, of 1884, the employment of an electrical condenser or condensers for the purpose set forth. 3. In telephonic switching apparatus the arrangement of induction coils and connections, substantially as described. 4. In telephonic switching apparatus the arrangements of an electrical condenser, or condensers and connections, substantially as described.

1610. "Improved construction of secondary or storage batteries." G. E. DORMAN. Dated February 4. 8d. Claim:—Secondary batteries, in which the elements are built up of a number of lead strips, piled one above another, the strips being alternately positive and negative, the strips being separated from one another by permeable material, substantially as herein described and shown.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this Society was held at the Institution of Civil Engineers on the 24th ult.

After the usual formal business,

Sir C. T. BRIGHT, President, announced that the Council had received from Lady Bolton an acknowledgment of the vote of sympathy and condolence in her loss, which had been conveyed to her on behalf of the Society. He drew attention to the annual balance sheet of the Society which had just been issued.

Mr. E. GRAVES, as honorary treasurer, remarked that there would be a credit equivalent to the item of £50, which appeared as extraordinary expenditure, being the Society's subscription towards the President's *Conversazione*, because the past president, Professor D. E. Hughes, F.R.S., had been kind enough to contribute that amount to the Jubilee Fund of the Society.

The adjourned discussion on Professor S. Thompson's paper on "Telephonic Investigations" was then resumed.

Professor FORBES thought it would be of interest to the Society while discussing the subject of transmitters if he described a novel though not particularly practical form upon which he had experimented, and about which he had that afternoon made a communication to the Royal Society. It was customary to divide transmitters into two classes, those having microphones with diaphragms, which always spoke well, and those which were microphones without diaphragms, and which spoke abominably. His new transmitter was probably of the latter class, but it was surprising to find that it acted at all. It consisted simply of a short piece of platinum wire which was made red-hot by the passage of a strong electric current, and when spoken to in that condition acted as a transmitter. The explanation of its action was simple, seeing that the sound waves of the voice, impinging on the wire, which was of a much higher temperature than the air of which they were composed, caused, by their cooling effect, a variation in the resistance of the wire, and those variations corresponded with the sound waves, and so the latter were conveyed through the primary circuit of an induction coil, and reappeared in the telephone receiver. A convenient size of platinum wire was that of ·001 inch, and good effects had been obtained from a length of three inches having a resistance of 30 ohms. (An experiment was made at the moment between two rooms, and Professor S. Thompson stated that he distinctly heard the counting of Professor Forbes, as well as the click when contact was made and broken). As to Professor Thompson's paper, he (Professor Forbes) objected to that part in which it was stated that "an unexcited electro-magnet placed on an iron diaphragm was practically useless to receive alternating currents from the secondary coil of a transformer," as also did he object to the beautiful and scientific diagram he had drawn up representing the points of greater and less magnetisation with or without a polarised magnet, as it had nothing to do with the matter at all. What was desired to obtain was not the greatest variation in the magnet of a telephone, but the greatest variation of attraction in the receiver, because it was the attraction of the pole for the diaphragm that determined the amount of motion given to the air to produce the best effect.

Major-General WEBBER drew attention to the good qualities of Professor S. Thompson's membrane receiver which he had seen in use on small lines throughout the country, and which rendered excellent service in some cases for long periods. He regretted that Mr. Preece had attracted their attention so much towards the comparatively large currents used for telegraphic apparatus, and had not dwelt more upon telephonic currents proper. Such telegraphic instruments as those of Meyer, Schaeffer and Baudôt, were probably worked with distinct make-and-break currents of the strength of ·012 ampère, which very soon limited the capacity of a line if their intermissions were at all rapid. Those systems were means of mechanically analysing the currents. There was one system which very nearly approached the undulatory description of the telephonic current, that was the harmonic system of Elisha Gray,

which was a system far more capable of elucidating the question of the capacity of a line for long distance telephony than any of those mentioned by Mr. Preece. He regretted the aspersion cast by Mr. Preece upon Professor S. Thompson for bringing his paper forward, especially because it must not be forgotten that the use of the telephone had become almost a monopoly. Every one wished to respect the rights of inventors, and to give them honour and reward, but when the combination of a carbon tension regulator with a tympan or diaphragm came to be interpreted as it recently had been, when almost everything was a tension regulator, and the human body had been classified as a tympan, he thought too much was allowed. Everybody desired that Professor Bell should receive all the honour to which he was entitled and be well rewarded; but the jury of the Paris Electrical Exhibition of 1881, after considering the claims of Elisha Gray and Graham Bell to be the inventor of the telephone, came to the conclusion that Elisha Gray searched for the telephone and found the harmonic telegraph, while Graham Bell searched for the harmonic telegraph and found the telephone; and the highest award of the jury, the Grand Prix, was given to each. But the fact remained that while Graham Bell got the honour and reward to which he was entitled, Elisha Gray received very little for his exertions.

Professor W. E. AYRTON pointed out that the question as to whether initial magnetism increased the sensibility of magnets had recently been fully gone into by Mr. Oliver Heaviside, who had come to exactly the same conclusion which had been known among electricians for a long while. As to the action of the microphone and the "bombardment" of the molecules, he considered that the action was similar to that of an arc lamp, and his opinion was based upon experiments as to the resistance of the arc which showed that the arc depended upon the ratio of the potential difference of the carbons to the current. The resistance of the arc varied with the current passing through it. The resistance of a microphone was measurable by the Wheatstone Bridge, and Mr. Shelford Bidwell had shown how that resistance varied with the current, and he (Professor Ayrton) had pointed out that the variation was exactly that which he and his colleague had found to occur with the resistance of an arc. Therefore, it was very reasonable to suppose that as the laws were similar so would the action be identical. He considered that the action of the microphone was improved by heat which reduced the resistance of the air and facilitated the discharge of the small arcs. As to the efficiency of a closed magneto circuit in an induction coil, he thought a closed ring would be an advantage if the primary currents were reversed and not merely made and broken. He differed from Mr. Preece's reasoning as regards the conditions which determined the speed of signalling in a submarine cable being the same as for a telephone line, because in a telephone line the mutual induction was infinitely more important than that of electro-static induction. The laws for mutual induction were unlike those for electro-static induction. Mr. Preece had stated that the electro-static capacity of an overhead telegraph line was ·013 microfarads per mile: that of a submarine cable was about ·3 or ·4 microfarads per mile, or some 30 times greater than an overhead telegraph line. The resistance of iron was about seven times that of copper, and as the speed of working depended upon the resistance per mile and the capacity per mile, it followed that, other things being equal, working by telephone with an iron wire would be better than with a submarine cable, but it was not so, because the self-induction of iron was greater than that of a copper cable conductor, and the best working of all was obtainable with an overhead copper wire. Therefore self-induction, and not simply electro-static retardation, had to be taken into account, their effects were entirely different, and the most important of the two for overhead telephone lines was self-induction. He looked forward to the time when special instruments would be used for sending and receiving by telephone to get over the line effects, just as submarine cable working was accelerated by Sir William Thomson's reflecting galvanometer and siphon recorder. As to patents, he happened to be in the peculiar position of not being pecuniarily interested in any, and was, therefore, free to consider the matter from a scientific point of view and without intentional bias in any one direction. Bell deserved all honour and credit for having done that which nobody had previously anticipated, *i.e.*, made an instrument very like a sounder speak to a similar instrument, but that form was not of itself capable of commercial use to any extent, and something else in the form of a microphone was required to make it practicable, and seeing that the article now used was not that claimed by Bell, he did not see that later inventors were to be severely charged with endeavouring to infringe Bell by trying to do that which he never attempted.

Mr. F. F. YEATMAN referred to the experiments of Mr. Giltay, who had inserted a battery and condenser in the secondary circuit of an induction coil, and thereby reproduced in the condenser sounds spoken to the microphone. Also Mr. Giltay had made a condenser speak to another condenser by introducing a large selenium resistance into the circuit; but his most famous experiment was that by which two persons who, with one hand each, touched one terminal of the secondary coil and presented the free hand to the ear of a third person who heard distinctly what was spoken to the microphone. The effects he (Mr. Yeatman) considered to be produced by electrical discharges.

Professor FLEMING did not agree with the objection which had been expressed in regard to Professor Thompson's use of the word transformer, seeing that it was used by Edison and others for transforming the voice, and in connection with motors. The telephone instrument really consisted of several parts or organs, not the least important of which was the transformer or induction coil. He agreed with Professor Ayrton as regards Mr. Preece's treatment of the problem for the transmission of speech, which was not the same as that for the tranmission of intermittent telegraphic currents. Lord Rayleigh had investigated the matter and found that when the pulsations of current were rapid the wire became choked or throttled. That effect was not only due to the line wire but to the secondary current of the induction coil, and therefore the careful construction of the induction coil became an important point in telephone working. The construction of induction coils did not appear to be based on any definite laws, and consequently various effects were the result. He asked Professor Thompson whether he had found that there was a particular frequency of the pulsation of current in an induction coil which gave the best transmitting condition. The self-induction of the induction coil was a very large portion of that of the whole circuit, and the solution of the problem of long distance telephony did not merely rest with the reduction of the self-induction of the line wire.

We reserve Professor S. Thompson's reply for our next issue.

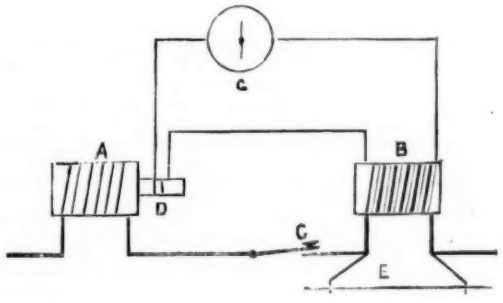
Physical Society, February 26th, 1887.

Prof. W. GRYLLS ADAMS in the Chair.

THE resolution passed at the meeting on February 12th, providing greater facilities to persons living abroad, for qualifying for membership of the society, was unanimously confirmed. The meeting was then resolved into an ordinary one, at which Prof. W. Stroud and Mr. G. S. Gulbenkian were elected members of the society.

"Note on Prof. Carey Foster's method of measuring the mutual induction of two coils." By JAMES SWINBURNE.

Towards the end of his paper Prof. Foster mentions that he hopes his method may be of use in dynamo work. Last summer, the writer, wishing to have means of testing the induction through any part of a dynamo and for testing samples of iron for Messrs. Crompton & Co., devised an arrangement which dispenses with the objectionable ballistic galvanometer. A rough experiment was then tried to see if the method would work well. A primary circuit was made through an electro-magnet, A, and one of a pair of coils, B, and a switch, C, was inserted. A secondary circuit was arranged, consisting of a pilot coil, D, round the electro-magnet, and the second coil of B with the ordinary reflecting galvanometer, G. A sliding contact shunt, E, to the primary coil, B, was arranged. This was fairly sensitive, but as the impulses were not at the same instant the light spot kicked each way



instead of remaining stationary. This effect was foreseen here, and might have been avoided by a different arrangement of E; but as it is unavoidable in a dynamo where the saturation coefficient of iron comes in, it was left. As no room suitable for this sort of work was available till lately, the apparatus was not pushed forward, but it is now nearly finished. The galvanometer was made for me by Mr. Dobson, lately one of Messrs. Crompton's pupils. It has a ballistic astatic needle, of the kind introduced by Ayrton and Perry, and if it jerks too much, two arms, like those of a little fly press, will be attached.

It was intended to calibrate the induction coils by comparison with a pair of such form that their mutual induction can be easily calculated; or by taking the induction through the neutral point of a dynamo armature, and then running the machine with the same field magnetising force. This method has, by the way, been recently mentioned by Mr. Kapp for calibrating a ballistic galvanometer. Probably now Prof. Foster's method may save considerable trouble if a good condenser is available.

The flywheel galvanometer may perhaps be used for other purposes, such as getting the ohm from a pair of coils whose mutual induction is known. For instance, the primary contact may be broken with a known frequency, and the secondary current commutated and taken through one wire of a differential flywheel galvanometer. The needle can then be brought to zero by a current in the other wire. This suggestion is made with some hesitation, as it seems as if some one must have thought of the

method before. It is infinitely easier to think of a real or apparent novelty, than to find out whether an idea is new. In looking the matter up for this note, it was found that the null method of comparing the mutual induction of pairs of coils is mentioned in a note at the end of Brillouin's elaborate memoir; while Roïti's arrangement is in Mascart and Joubert, and Maxwell mentions the use of a flywheel galvanometer for integrating condenser impulses.

Discussion.

Prof. AYRTON thought hearers might be unintentionally led by Mr. Swinburne to think that Prof. Foster had not used the null method. The great beauty of Prof. Foster's method was that he dispensed with the ballistic galvanometer which was a great advantage. Not only was the ballistic galvanometer troublesome to calibrate, but corrections for logarithmic decrement had to be made. In practice, Prof. Foster's method was greatly superior to those given in Maxwell and the ordinary text books. The chief drawback was the necessity of having large condensers of accurately known capacity where large co-efficients are concerned. A large number of experiments had been carried out at the Central Institution by Mr. Sumpner with very satisfactory results.

Prof. ADAMS concurred in Prof. Ayrton's statement regarding the difficulties in using Maxwell's methods in practice, and expressed his satisfaction with the great simplicity of Prof. Foster's method.

A paper by Mr. R. H. M. BOSANQUET, M.A., "On the determination of co-efficients of mutual induction by means of the ballistic galvanometer and earth inductor," was then read. The methods described depend on two measurements of the throws of a ballistic galvanometer; first, that produced by the sudden rotation of a coil (the constants of which are accurately known) through 180°, about a vertical axis; and, second, that produced by the mutual induction to be measured, when a current of known strength is started in the primary circuit. The earth induction coil is permanently joined in series with the ballistic galvanometer and secondary coil, and the primary current measured by an absolute tangent galvanometer of the Helmholtz pattern.

If Q_0 and Q be the quantities of electricity which pass through the ballistic galvanometer in the two experiments, then $Q_0 = \frac{2 N A H}{R}$ where N A is the effective area of the inductor, and $Q = \frac{M C}{R}$ where $C = G H \tan. \theta$.

Hence $\frac{Q}{Q_0} = \frac{M G \tan. \theta}{2 N A} = \frac{\alpha}{\beta}$ where α and β are the throws of the ballistic galvanometer. From the above we get

$$M = \frac{\alpha}{\beta} \frac{2 N A}{G \tan. \theta}$$

A modification, to be used when M or R are very large, is also described. Numerical results obtained are given, from which it is inferred that Maxwell's formulæ for calculating the mutual induction of two circular coils, cannot be applied where the distance between their central planes is at all comparable with their radii. Experiments on an A Gramme dynamo gave very irregular results when the currents were small, owing to the subpermanent magnetism of the machine. Further uses of the method are suggested, such as the absolute determination of capacity and resistance.

The continuation of the discussion on Mr. Swinburne's paper was then taken in conjunction with that of Mr. Bosanquet's.

Mr. SWINBURNE said he thought Mr. Bosanquet would get more accurate results if he took the induction through the armature of his dynamo by means of a coil round the neutral point. He seemed to have made connection to the commutator, and his reading would depend on the field. He also thought Prof. Foster's method had a drawback in depending on a condenser which was itself measured by a ballistic galvanometer.

Prof. CAREY FOSTER drew a diagram of Roïti's arrangement, and explained the difference between it and his own.

Prof. AYRTON said there was no difficulty in comparing one condenser with another, and the standard condensers made by Fleeming Jenkin were, of course, correct.

Mr. SWINBURNE said that he would rather use a pair of coils than a condenser, and they were easier to make.

Mr. BOSANQUET said Mr. Swinburne did not seem to realise the errors that arose in calculating coils. In his paper he had shown that Maxwell's formulæ gave results that were largely out.

Mr. SWINBURNE said that depended on the forms of coils chosen. A very long solenoid with a pilot wire round it would be accurate.

Prof. REINOLD then read an abstract of a paper on "The Continuous Transition from the Liquid to the Gaseous State of Matter at all Temperatures," by Prof. W. RAMSAY and Dr. SYDNEY YOUNG. The authors find the relation between pressure and temperatures of gases and liquids at constant volume expressible by $p = b t - a$ where b and a are constants, and therefore conclude that the *isochors* (*i.e.*, curves connecting p and t for constant volume) are straight lines. At temperatures below the critical point, the isotherms during passage from the gaseous to the liquid state, is a serpentine curve intersected by the horizontal line of vapour pressure corresponding with that temperature, the two areas between the curve and straight line being equal. By experiment and extrapolation the authors find the loci of the apices of the serpentine curves corresponding with different temperatures to intersect at the critical point. The above results are proved for ether and carbonic dioxide, and the authors believe them to be true for all stable substances.

Prof. RUCKER remarked that if similar relations hold for liquids and solids, the triple point of intersections would be of immense interest.

Prof. PERRY, whilst regarding the results as of vast importance, thought the curves and calculations should be very carefully discussed before being finally accepted.

CORRESPONDENCE.

Mr. Sprague's "Challenge."

Mr. Mordey has forwarded us a copy of a letter which he has addressed to the editor of the *Electrical World* in reference to the "challenge" of Mr. Sprague, and this we reproduce as follows:—

"In a recent number you published a letter from Mr. F. J. Sprague which has placed me in a rather difficult position. It seems such an extraordinary thing to issue a challenge on a matter which has no bearing whatever upon the points at issue, and which even if accepted could lead to no useful result, that I do not feel sure that the letter is intended to be taken seriously. If, therefore, in treating it seriously I am acting under a misapprehension, I must plead in extenuation my desire to show no want of respect to Mr. Sprague, whose energy and skill in applying electricity to purposes of locomotion are worthy of admiration.

"Mr. Sprague accuses me of having 'joined the hunt and raised the cry against the originality of his work,' but he does not quote the passages or the statements to which he objects, nor does he endeavour in any way to show in what I am mistaken. I find that my only mention of Mr. Sprague's work was in an article in the London ELECTRICAL REVIEW of December 24th, when I referred to two points which had been described, respectively, as Mr. Sprague's 'main principle,' and his 'law of winding,' and pointed out that they were not new. The 'main principle' was that of regulation by inverse variation of field excitation, which, of course, is the idea underlying the well-known differential winding of Profs. Ayrton and Perry. The 'law' referred to is the following:—'The number of turns in the shunt coil must bear the same ratio to the number in the series coil as the resistance of the shunt coil bears to the sum of the resistance of the series coil and the armature.'

"This so-called law of differential winding is a development by Prof. Silvanus Thompson of Profs. Ayrton and Perry's system, and is given in his 'Dynamo-electric Machinery,' first edition, p. 367.

"These, then, are the only questions on which I have 'joined the hunt and raised the cry' against Mr. Sprague; and, to use a figure from the same source, it is across this scent that he has 'drawn a red herring' in the shape of a challenge which, as I have already intimated, has nothing to do with the case.

"Mr. Sprague has not time, he says, to enter into any discussion whatever of the questions that have been raised. It certainly seems to me that it would have taken him less time to give the reasons, whatever they may be, on which he bases his objections to the opinions of his critics, than to write his remarkable letter; and I cannot but think that time was not the only thing of which his supply was insufficient.

"As to the challenge itself—to build two motors from designs dating back not less than five years—I feel that by meeting Mr. Sprague's wishes in this matter I should only be making a demand on his time which would prevent him from devoting himself to the real issue.

"W. M. Mordey.

"*February 28th*, 1887."